

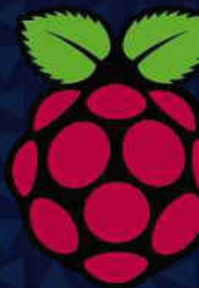
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Welcome!



WHEN WINDOWS 10 came out, the entire *Shopper* team breathed a collective sigh of relief: Microsoft had banished the demons of Windows 8 and

created an OS that was truly great and worth upgrading to.

Now you've had time to play with it on your existing computer, why not build a brand-new computer that you've designed for it? Starting on page 86 we've reviewed everything you need to build a new computer, including processors, RAM, motherboards, cases, power supplies, hard disks and SSDs.

We've done our group test in a different way, too. This time round, we've tested far more products than we could fit into the magazine, so we can present to you only the very best products. The result is that you'll easily be able to find the right products for your build, whatever your budget.

As good as your own PC is, the one thing we can't promise you is that your computer will be faster than Google's and NASA's quantum computer. In

certain tasks it's a cool one million times faster than a regular PC. You can read all about it on page 118.

If you can forgo total power and would rather just have a computer that's small, cool and easy to manage, then you need to read our instructions on how to turn your Raspberry Pi into a full computer on page 143.

It's been a great month for technology in general, particularly as Ultra HD Blu-ray finally moves into production. With this new format, you'll be able to watch lots of extremely high-quality films and TV shows on your TV, as we explain on page 22.

Finally, on page 124 we've taken a detailed look at the Minecraft phenomenon. Although it tends to be more popular with kids, there's more to this game than you might think. Approaching it from the point of view of an adult, our guide will show you what Minecraft is capable of, as well as taking you through some of the best worlds and builds it has to offer.

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QUESTION OF THE MONTH

Which 4K Blu-ray would make you buy a player and a new TV?

MEET THE TEAM



Chris Finnamore

“Jet Li's *Hero* – a truly epic tale that's full of action and emotion”



David Ludlow

“*Total Recall* (the Arnie version). It's the greatest film ever made”



Richard Easton

“BBC's *Planet Earth*, for a sense of continuity”



Seth Barton

“*My Little Pony: Equestria Girls* – it's for my daughter, honest!”



Katharine Byrne

“The 1993 *Super Mario Bros.* movie, just to marvel at its sheer awfulness”



Michael Passingham

“I'd love a 4K edition of the *World Rally Championship* Review DVDs: high-def gravel!”

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OR SEE PAGE 134**

Contents



Learn

136 Business Help

Our resident expert answers those persistent software queries

138 Helpfile

Step this way for all your hardware and Windows problems

140 Multimedia Expert

Photos of smoke can look amazing, taking on an other-worldly appearance. We show you how to get the best results

143 Advanced Projects

We show you how to turn your Raspberry Pi 2 into a full computer, complete with a case, power switch and full operating system

Regulars

6 Letters

Your regular monthly missives of wit and wisdom

10 Under Development

A stag do full of Ali G lookalikes and a foul-mouthed Effin' Jeff to deal with are just the start of **David Robinson's** problems this month

12 Cybercop

If you've had your computer attacked, taking online revenge against the perpetrators might seem like a good idea – but be warned, you could be biting off a whole lot more than you can chew

14 Rants & Raves

David Ludlow can't believe how stupid the government is with its new snooping laws, while **Mel Croucher** is [happy face], [thumbs up], [winking], as he marks the end of the English language as we know it

146 Zygote

The science of the bleedin' obvious, the tragedy of not being able to mock a dead dog and the problems with drones all come under **Zygote's** watchful eye this month

News

16 Newsfile

Our round-up of the latest technology news, including an in-depth report from CES 2016

22 InDepth

Ultra HD 4K Blu-ray is finally on the way, but is it any good? And when will you be able to get it? We find out



Features

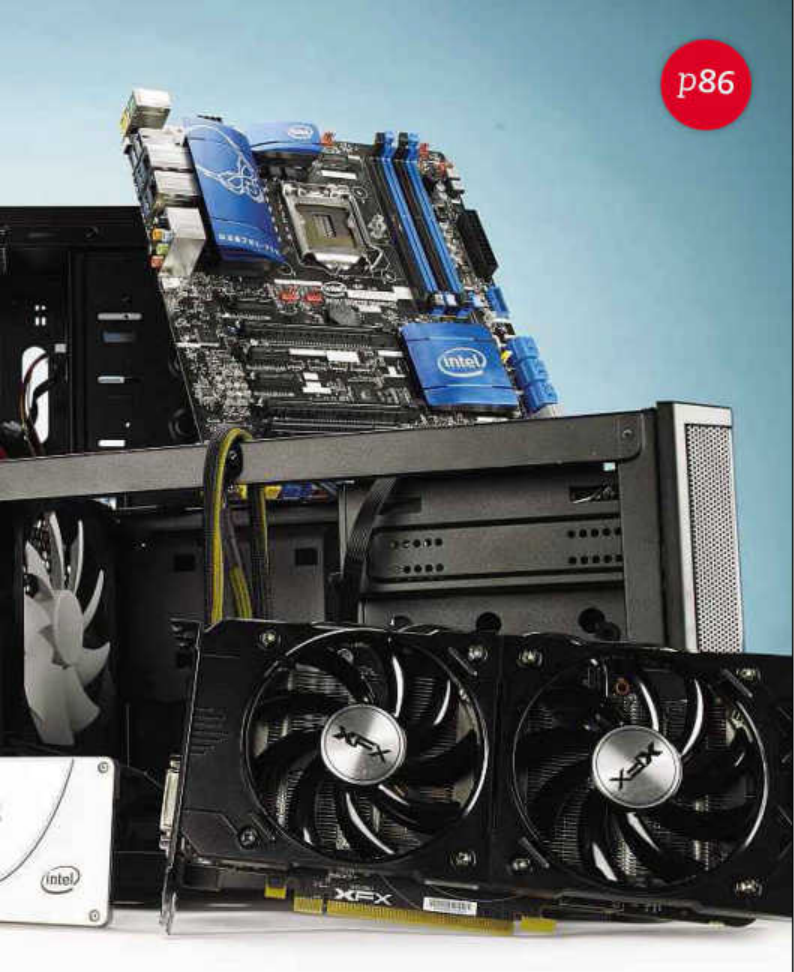
118 Quantum Leap

Quantum computing might seem baffling, but the technology now works brilliantly. We find out how Google's and NASA's quantum computer performs some tasks one million times quicker than yours

124 Minecraft: The Grown-up's Guide

It's the Lego-style building game that's taken the world by storm, but Minecraft is mostly played by children. In this guide we find out how it can appeal to adults, how you can enjoy what your kids and grandchildren are up to, and the most amazing Minecraft locations you can visit





Reviews

24 This month's hot product

Dell's XPS 15 is a stunning Windows 10 powerhouse with a gorgeous InfinityEdge display. Can it rival Apple's MacBook Pro?



26 PCs & Laptops

With its great design and fancy convertible display, Acer's Chromebook R 11 is our new favourite Chrome OS machine

32 Handhelds

The OnePlus 2 is a flagship phone at a rock bottom price, and it's finally available to buy invite-free in the UK (p33)

39 Photography

Take SLR-quality photos and shoot 4K video with Sony's pocket-sized Cyber-Shot RX100 IV (p40)

42 Displays

Philips' new 34in monitor has curves in all the right places – and fantastic image quality

44 Home Cinema

Samsung's JU7500-series TV has a superb 4K display and one of the best smart TV interfaces around

47 Audio

Get the most out of your high-res audio files with Pioneer's portable media player, the XDP-100R (p48)



52 Printers & Scanners

Canon's Pixma MG5750 (p53) is an inkjet multifunction peripheral that's cheap to run and produces great-quality printouts

54 Networks

Make your home smarter and control it from afar with Devolo's Home Control Starter Pack



58 Software

Turn your photos into digital paintings and draw with musical accompaniment in Corel's Painter 2016 suite (p59)

60 Games

Lara's back for a new adventure in the snowy Siberian mountains in Rise of the Tomb Raider

64 Best Buys

Looking for the best kit we've reviewed recently? It's all in our Best Buys section

78 How We Test

Our tests, ratings and awards explained

Group Test

86 Components: Build Your Own PC

With the quality of Windows 10, there's never been a better time to build your own PC, but which components do you need? To help you choose, we've rounded up the best processors, motherboards, power supplies, RAM, hard disks, SSDs and cases. With something for every budget, you'll be able to find your perfect building blocks



80 Your software*

Bring your creative ideas to life with the powerful yet easy-to-use DTP favourite, Serif PagePlus X4



6 FULL PACKAGES

* FREE SOFTWARE EDITION ONLY

Letters

We're here to help with all those niggly Windows 10 queries – and if we can't help, one of knowledgeable readers surely will. The only thing we can't help with is that Lady Gaga desktop theme

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"HEROES"



I want to say a huge thank you to *Computer Shopper* and Ian Thompson for resolving my Windows 10 Upgrade problem.

I sent an email to help@computershopper.co.uk in December 2015 explaining that the Windows 10 checker said my CPU wasn't supported, when it is. I was pleased to see a fellow subscriber, Ian Thompson, posted a reply to my request for help in *Letters*, issue 337, with a possible solution. Essentially, he said that he had previously set

Data Execution Prevention (DEP) in Windows 7 to apply only to essential Windows programs and services and that switching it to 'All' resolved his similar issue and therefore should resolve mine.

I checked and my DEP was set to essential Windows programs, so I selected the option for all programs by doing this: first, open System by clicking the Start button, right-click Computer and click Properties, then click Advanced system settings. If you're prompted for an administrator

password or confirmation, type the password or confirm as necessary. Under Performance, click Settings and then click the Data Execution Prevention tab, and then click 'Turn on DEP for all programs and services except those I select'.

I had to wait for the Windows 10 upgrade advisor to check my system again (it seems to do it once a month, so I had to wait until 19th January), but my PC was marked as compatible. So many thanks again to *Computer Shopper* and Ian Thompson.

Roy Davies

We're glad that Ian's information helped and that you're now running Windows 10. For anyone else with the same problem, you can skip the part where Microsoft has to check your PC for compatibility by downloading the Windows 10 Upgrade Tool (tinyurl.com/Win10upgradetool) and running it manually. It will check your PC and perform the upgrade all in one go.

SPACE ODDITY



The latest build of Windows 10 appears to be more tolerant of hardware

★ Star letter

STARMAN



I read with interest your anti-virus group test (*Shopper* 336). Having recently replaced Microsoft Windows Defender with AVG's free anti-virus package, I was surprised to see AVG was rated so poorly. According to your results it has the lowest "protection breakdown" rating and a low overall "protection rating", lower than Microsoft's Security Essentials.

Before replacing Windows Defender with AVG, I had read AV-Test's report on the performance of different anti-virus packages, which showed AVG Internet Security having protection performance on a par with Kaspersky Lab's Internet Security and Norton Security, both of which received top ranking in your report. Additionally, it showed Microsoft's Windows Defender with the lowest protection ranking, lower than Microsoft's Security Essentials indicated in your article.

Clearly your report by Dennis Technology Labs and AV-Test use different ranking schemes; however, it would be

interesting to know whether these test methodologies account for the difference in performance. Is the protection offered by AVG's commercial and free anti-virus packages the same, and does the use of Security Essentials (Windows 7) or Windows Defender (Windows 10) account for the differences?

In the meantime, I've decided to replace AVG's free anti-virus software package with Kaspersky Internet Security, given its high protection ranking both in your article and the AV-Test report.

Stephen Truelove

One of the big issues with testing security software is how quickly things change. All the testing in Dennis Technology Labs uses live viruses found in the wild, with the latest tests taking place between October and December 2015. Using real threats is great, as it shows how software really performs, but as the type of threats change, so do the



protection scores. What our results show is that all the software on test is pretty good at defending against the current type of threats.

In terms of weighting, we place higher regard on a piece of security software that blocks a

threat completely, rather than one that allows it to run, before blocking and neutralising it. For this reason, Microsoft Windows Defender did better than AVG. We can't speak for AV-Test, as its testing methodology and time of test would have been different to ours, although we can vouch for the quality of its testing.

We think the important thing to point out is that the free software (AVG and Microsoft) tends to fluctuate more in quality, whereas the paid-for software, such as Kaspersky, has been rock solid for years on end. As such, we recommend free software as a baseline defence, but the upgrade you made to Kaspersky will dramatically improve your protection.

upgrades than many had feared. I recently upgraded my PC's motherboard, processor and RAM. Most people would advise carrying out a fresh operating system installation after such a major upgrade, but I decided to boot the existing installation to see what happened.

To my surprise (and delight) both Windows 10 and Mint Linux booted flawlessly first time; Windows did pause for a few seconds to reconfigure some device settings, but that was it. A quick trip to Device Manager to uninstall redundant drivers (two minutes' work) and all was done. Now Windows did ask for reactivation, but it accepted my Windows 7 licence key without a hitch.

The only disappointment was that Windows XP (which I retain to run a venerable old Sound Blaster card occasionally) bluescreened, but I can probably reinstall it. Well done Microsoft (and Mint) for producing flexible, resilient upgrade-tolerant systems.

Chris Stewart

CHANGES

After reading Richard Sanders' letter in *Shopper 336*, I think I may have a solution. I have upgraded a lot of machines for myself, friends and family to Windows 10. Usually the upgrade has gone smoothly; however, one problem I have noticed when upgrading older laptops from Windows 7 is that Microsoft tends to replace the manufacturer's Wi-Fi driver with a generic one of its own, and sometimes this driver isn't very good or very stable. I suspect this may be Richard's problem.

If the laptop manufacturer's website does have a Windows 10 specific driver, then I have often got round this by downloading and forcibly installing the original Windows 7 driver; this appears to solve the problem in most cases, noticeably Dell-branded Broadcom adaptors. No guarantees, but it does seem to work.

David Pinfold

Wi-Fi adaptors can be the biggest pain to deal with,

particularly on older hardware. Microsoft appears to be trying to deal with the problem for upgraders by forcing people to use its driver, under the idea that it's better to have an internet connection than no internet connection. Your advice is extremely helpful and we encourage all readers to look for updated manufacturer drivers for their computer rather than relying on the Microsoft versions.

GOLDEN YEARS

May I nominate the BT billing program for this year's Corporate Software Failure award? A recent bill has demonstrated that this program, which is responsible for billing millions of BT customers each month, is capable of charging simultaneously both for "Unlimited Broadband (BT Infinity 1)" and "Additional Broadband Usage". Your readers will undoubtedly have other nominations.

John Prowse



That certainly gets a slow hand-clap from us. If any other readers have similar tales, please send them in to the usual address: letters@computershopper.co.uk.

THE MAN WHO SOLD THE WORLD

My Asus TF701 Transformer Pad is two years old and I am looking for a replacement with the latest more powerful, power-efficient processors and the latest version of Android.



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But where can I find one? Nothing I can see in your reviews matches the spec. The 2,560x1,600 screen has been improved, but is that really necessary on a 10in tablet? The 1.9GHz quad-core Tegra processor can be bettered and 3GB or more RAM would be better than the 2GB I have, but time and again the latest tablets leave out any microSD card slot.

And then there's the keyboard. Not just a docking keyboard as opposed to a Bluetooth clip-on, but with a back-up battery, a USB port and a full-sized SD slot. After a day on the road, back at home or my holiday hotel, I can clip on the keyboard to breathe a bit of life back into the depleted tablet battery, plug in a USB travel mouse, insert the SD card from my camera and review my photos; I can even view them on any HDMI TV screen via the tablet's Micro HDMI port. I can back up my precious holiday pics to the microSD in the tablet, then read and reply to my emails. It is so much easier to

work with keyboard and mouse than it is to jab at the screen.

So there is my problem. Do I just soldier on and hope that Asus will be able to replace the battery when it eventually gives out? Or was there anything at CES 2016 that will be coming to market later this year?

Bob Delemere

You're right: there are few tablets that do everything that yours does at the moment, with many of them basically little more than a touchscreen. However, there are other suitable models, from those that run Android to full Windows 10 computers. We've got a full tablet group test coming up in two months' time, so stay tuned for more.

LADY GRINNING SOUL



I have just upgraded from Windows 8.1 to Windows 10, and all went well. I then set about doing a clean install (guided by your article in *Shopper 332*). After being told that everything on the hard disk would be wiped, I carried on.

What a surprise, then, to find my Lady Gaga desktop theme had survived the clean install and was still there. I know she's a strong lady, but to beat a disk wipe and Microsoft is something else!

I was also surprised to find, after reinstalling all my software, that my much-loved Photoshop Elements 2 (yes, 2) still worked. It's been with me through many computer and OS upgrades going back to Windows 98 SE.

I do know that some later editions of Photoshop Elements didn't work on OS upgrades, but Elements 2 does and, as always, has done the job with excellent results with no need for upgrades.

To think what I might have spent on all those Element upgrades, which most people don't really need. I have to say Elements 2 has undoubtedly been the best £50 I have ever and probably will ever spend on software. All this now poses the question of what else survives, be it after clean installs or older software?

Neil Roe

The most likely explanation for Lady Gaga's continuing habitation of your PC is that your desktop information was synchronised to the cloud via your Microsoft account. After you'd reinstalled and logged back in, the data was most likely pulled back down from the internet and reinstalled as though it had never gone away. It's things such as this that show how powerful cloud computing can be.

That's brilliant news about Photoshop Elements still working. You're right that many people upgrade without necessarily having to. In fact, software is hard for us to rate: we have to give a star rating based on how good a piece of software is today, not how it compares to a previous version. In other words, our ratings are really for people new to the software; however, if a new version is not a great upgrade for existing users, we always mention this in the conclusion in order to try to stop unnecessary upgrades.

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NEXT MONTH

› BUILD A BETTER PC

From the initial planning to the finished build, we take you through all the steps you need to make your own perfect Windows 10 PC. We're kicking everything off with detailed instructions on how to choose the right components for any budget, showing you where to cut corners safely and where to spend a little more.

› MULTIROOM AUDIO

Delayed for a month because of our huge components megatest, our guide will help you find the perfect audio kit, so you can play music effortlessly throughout your house.



› F1 TECH

We take a look behind the scenes of Formula One, finding out how new technology is powering drivers to victory.

› IMPRESSIVE OBSCURE TECH

Our intrepid reporter goes to the dark recesses of the CES show in Las Vegas to find the top tech that you've never heard of.

› MAKE YOUR OWN NAS

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OVERCLOCKERS UK



SCAN
computers

Effin' Jeff in da house

A bunch of Ali G lookalikes, products that mysteriously change their identity and a potty-mouthed customer are driving **David Robinson** to the edge of despair



DAVID ROBINSON
Software and systems developer
letters@computershopper.co.uk

IT'S 7am AND pouring down outside. I'm facing the wall in the gents' loo in Manchester Airport. In the 'space' next to me is a man dressed in a baby blue and yellow shiny silk shell suit. He has dark hair, a fake tan, droopy 'tache and a headband. I return to the restaurant, where Mrs R is eating breakfast, and report that I've just had a wee next to Ali G. She points out there are 19 more of them right behind me. Plus their mate Superman.

We're on our way to Baton Rouge, Louisiana, Mrs R to do an accounting system upgrade and me to work with a 'cust2mer' (a customer's customer) automating the electronic data interchange (EDI) on one of their projects. It's a fair bet the Ali Gs are on a stag trip, and they're already lined up at the bar. I hope they're not on our flight to Atlanta, where we change for Red Stick.

The accounting software update is years overdue, not because we don't do these things on time but because our old foul-mouthed friend Effin' Jeff, who owns the company, doesn't like spending money on stuff like software, which is, apparently, working OK. When it comes to squeezing blood from a stone,

sub-assemblies may have been made by a variety of minnows. In this instance EJ Inc has struck lucky and gets to make some bits, plus has the glory of bolting it all together. But to do this they need lots of detailed information on the composition of the whole project, including the bits they're not making, and they also have to frequently report back their progress. There are lots of bits and lots of protagonists, which is where the EDI system comes in.

SPREAD BETTING

I ask for a specification of the EDI system. What I get is a list of spreadsheets that get emailed back and forth. The process, as described, is vague. This is not good. Also, spreadsheets are great for some things but not as a systems component, because it's easy to enter data into a sheet so it looks valid but actually isn't. The bigger the sheet, the harder errors are to detect; and these are up to 1,000 rows with 45 columns. Our task is to create the spreadsheets automatically from data in the existing management control software, which we supply to EJ.

Jake from the engineering firm sends me a sample spreadsheet. Each row contains data for a component in the project. The first column contains a serial number, which is supposed to identify each component uniquely. Now, when I think of a serial number I expect it to look something like 1234567890-22. Lenny the Lenovo's serial number is 0807946683. Not too difficult.

The shortest in the sample spreadsheet was SNWP99864-A STU-77-51401122015-0000000005/JGZ88 – that's 46 characters. Jake says they can be as many as 80 characters long, which is nuts. Even worse is the series of nine zeros in the middle. It's easy to record one zero too few or too many. And serial numbers matter. If you weld on the wrong part the whole thing can blow up.

Even worse, serial numbers change during the course of the project. The number reflects the stage it's reached in the progress of the whole project. This is dumb. By all means store progress data in the record of a component but not in a field that identifies the part itself. Then Jake tells us we can only send update information back to his company once for each part. If we send information for SNWP99864-ASTU-77-51401122015-0000000005/JGZ88 more than once the system will assume we have two of them and create two records. Argh!

COST ANALYSIS

Jeff has two questions: when can we implement the software, and how much will it cost? Jeff had assumed our custom software that runs the operation would already do all this (why?) and had promised the multinational company it would be ready to roll "by the end of the month". His own staff had put him right on this – hence the expense of the visit. As to cost, it was a question of how many arms and legs.

There are ways of getting round the long serial number problem and also preventing a 'double send', but the morphing part ID is troublesome, not least because Jake can't tell me exactly how and when it changes.

Just as I'm beginning to wish I'd swapped queues at the airport and tagged along with the Ali Gs, I get a call from Jake's boss asking how we're progressing. I outline the problem with the shape-shifting serial number. "Who told you that crap?" he wants to know. "Er, Jake," I reply. "Well, that's bullshit," he says, adding that Jake's only been in the job three weeks and "doesn't know his ass from his elbow".

At least I can now get him a working system "by the end of the month", so everyone's happy. Until Jeff gets the bill, that is, when I'm sure he'll live up to his nickname. ☹

The system update is years overdue because Effin' Jeff doesn't like spending money on stuff like software

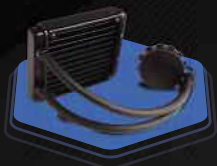
Jeff's an Olympic champion. But now it's about to not work OK because the old software won't run on Microsoft's latest server operating systems, and they're due a server replacement.

The cust2mer, a multinational engineering company, contracts out a lot of its production to relative minnows such as EJ. They do the design work, then tell the minnows to make it. Often the finished item is huge, and lots of



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Don't hack back

If you've been the victim of a cyberattack you might feel like exacting revenge on the perpetrators, but it wouldn't be a wise move – even if it may soon be legal



GORDON HOLMES

With more than 30 years of experience in law enforcement, our retired cop gives a police officer's perspective on the sticky subject of cybercrime
letters@computershopper.co.uk

I WAS ONE of too many people packed uncomfortably into a hot carriage when the train pulled into Vauxhall station. A few new passengers managed to squeeze in and the train was just about to pull out when one final, frantic man threw himself in through the door. Everyone felt the impact and lost another fraction of their breathing space and patience.

"Ass!" exclaimed one voice. The latecomer lashed out, striking a nearby onlooker, who asked, "Why did you hit me?" "You called me a rude word," said the man. "No, he didn't, I did," called out the American voice who had started the exchange. The predominantly British congregation broke the first rule of commuting, whereby everyone ignores awkward situations by staring at their newspapers, and jeered loudly. It was magnificent.

There's a connection between this incident of mistaken identity and the problems inherent in the idea of attacking back against hackers. The United States is currently looking into legislation that supports US companies retaliating against cyberattacks. Most countries' laws forbid

more likely to use other victims' systems, or proxies, VPNs or other anonymising systems, such as the Tor network.

If an attacker is coming at you from another victim's computer, and you break into that system in response, you're punching the guy in front of the commuter who offended you. If the attacker is using Amazon Web Services as a proxy you'll end up launching an attack against one of the largest companies in the world. I hope your legal war chest of funds can compete, should you be detected and prosecuted.

DIVINE ATTRIBUTION

Attribution, the process whereby analysts decide who launched an attack after the event, is hard to do well. US-based security firms often claim that most attacks against American businesses are orchestrated by agents of the Chinese government. The basis of this analysis can be something as simple as looking at the internet addresses of the attacking systems or, in more convincing cases, deep analysis of the malware used to compromise systems.

The fact is that hackers launch attacks from systems all over the world. If most attacks appear to originate from Russian cyberspace it seems particularly lazy to leap to the assumption that Russian criminals or government agents are behind them. It's more likely that other nation states are proxying through Russia to avoid attribution. They are in effect pushing Russia to the front of the train carriage to face the aggressive commuter.

There's another downside to fighting back: you might just start something you can't finish. Maybe you correctly identified the opponent and are confident you've targeted the appropriate computer systems. And maybe you don't believe the authorities will become involved because your guilty target, who started it

in the first place, probably won't tell tales. But unless you're a skilled hacker with an arsenal of advanced tools for attack and defence you probably won't come out of this fight well.

You were hacked before, so clearly your defensive capabilities are not world class. You might be better off fixing that, rather than punching back. Don't forget, too, that once you start playing with the big boys things can quickly escalate. You may be a ninja behind the keyboard, but you can't assume that hostilities will remain online. A home visit from your opponent, or more likely his associates, would bypass any firewall and could end up being painful at best.

JUSTICE OF THE PIECE

And where does it end? What do you want to achieve by fighting back? Is a sense of 'justice done' enough and, if it is, how much damage do you need to inflict on the target's systems before you feel vindicated? If your target has backups you might need to lurk on his network for months, slowly damaging his files until his backups become useless. If you lost intellectual property in the original attack you may want to steal secrets in return. How many secrets will balance things out? Hacking back and exacting revenge takes time and energy that might be better spent improving your own security.

Even if the law changes and it becomes legal to fight back against hacking attacks, it's not going to be a feasible or wise response for almost any individual or organisation. You need the ability to identify a valid target; a goal that provides you with value beyond a sense of revenge; resources to achieve your goal; and the ability to protect your physical self against a physical attack. If you can do all of that you might consider a job at GCHQ, which is always keen to expand its cyber capabilities. **CS**

If someone breaks into your computers and steals data, who do you punch back?

hacking, whether as an initial act or in response to an incoming threat. Now there's a possibility that companies can react in kind against being hacked.

If someone breaks into your computers and steals data, who do you punch back, virtually? The owner of the system that launched the attack? Their ISP? Or their government? To fully appreciate the problem with fighting back you have to understand how most hackers operate. For one thing, they rarely use their own computers to launch an attack. They are far

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RANTS & RAVES

While smart technology and simple people find new ways to communicate, the Home Office explains its Investigatory Powers Bill through the medium of contradiction

David Ludlow

RAVES

A lack of communication can leave our smart gadgets a little dumb, but one ingenious online service promises to help them get along famously



AS SMART AS our technology has become, almost every individual product you use speaks its own language that nothing else understands. This leaves us with a confusing mess of logins, different apps and multiple ways of doing things. Wouldn't it be great if there were a single way for our gadgets to communicate – an Esperanto for the technology world, if you like, only not rubbish?

That's exactly what IF This Then That (IFTTT, www.ifttt.com) does. As the name suggests, this web-based service lets you create scenarios where a trigger (the IF This part) leads to an action (the Then That part). With a little support from the manufacturer, you can use the system to make different pieces of technology work together beautifully.

For example, using IFTTT with an iPhone, I can get the service to monitor my location so that when I leave a

specific area it switches off my heating (again, thanks to integration with Honeywell's smart thermostats). Likewise, when I get back into the trigger zone, IFTTT can switch the heating back on. I can even set it to change the heating based on weather reports – so if the outside temperature hits 16°C, for example, it could turn off the heating completely, only turning it back on when the temperature drops.

When you start to include other smart home kit, you suddenly expand what the program can do. For example, a motion sensor that turns on a light could trigger an alert to tell you that someone has entered your house. And why bother with a dusk-to-dawn sensor when you can use IFTTT to flick your outside light on and off at the right time automatically.

Actions don't have to be physical, either. You can monitor your Instagram

account, for example, and post pictures to your Facebook and Twitter pages automatically. Or you can create a ToDo list automatically from emails that you mark in Gmail. In short, you can pretty much link any two services together to do things that neither manufacturer would have thought of or implemented themselves.

Essentially, IFTTT breaks down the barriers that stop different pieces of technology working together, without the need for companies to agree on potentially restrictive standards. It also means you're free to buy your kit from different manufacturers. Want your Belkin MeMo light switch to turn on your Philips Hue light? No problem. Want to use an email to set an iOS reminder? It's done. We need much more of this type of interaction, as it brings technology together and actually makes life easier.

David Ludlow

RANTS

Don't worry, the government isn't interested in breaking our encryption and keeping all our data. It's only haystacks they're after

A LITTLE KNOWLEDGE is a dangerous thing, as the Home Secretary continues to prove with her snoopers' charter. In January, Theresa May defended the Bill in parliament by completely confusing the situation.

May says she doesn't want a backdoor to encryption, but she also said: "What we are saying to companies... is that when a warrant is lawfully served on them there is an expectation that they will be able to take reasonable steps to ensure that they can comply with that warrant, ie that they can provide the information that is being requested under that lawful warrant in a form which is legible for the authorities."

So how can a company provide access to encrypted data unless it puts in a backdoor? Well, there is an alternative: it could use encryption that's so weak it's easy to break.

May and her advisors fail to appreciate that encryption is a key part of the internet and privacy. You can't simply make it easy for governments to access encrypted data without breaking that privacy. It's like asking people to use old locks on their cars so the police can open them with a coat hanger if they need to. Who would ever abuse that?

On top of that, the government wants all companies to store all data. Even your local coffee shop will have to store all the data



that flows through its free Wi-Fi network – and entirely at its own expense.

Again, it's not that May wants to store all this data but, as she stupidly puts it, "We have to have a haystack to be able to find the needle that we need to keep the public safe." Only, it's not a haystack, it's a giant warehouse full of haystacks.

May doesn't understand this, which is why we should start by CCing her in on every email we send and posting USB flash drives with copies of every website we've visited. I'm starting with all the negative coverage her stupid Bill has inspired. Now, where did I put that 300,000TB flash drive?

Mel Croucher

RAVES

A picture may be worth a thousand words, but a handful of emojis could be set to replace the entire English language

WORDS GET US into all sorts of trouble, because words are often misunderstood. Especially words emailed after a few too many shandies. Luckily, words will soon be redundant, so the risk of unintended consequences will be greatly reduced. All thanks to emojis. Emojis are those cute little graphic symbols embedded in the Unicode software that runs in all our smart devices, and they provide us with a crystal clear method of communication. They were originally invented to help young people to express themselves electronically, and they allow all human thought and expression to be limited to eight categories of pictogram.

This is a liberation for disadvantaged folk who can't speak perfect English, like the Japanese. And for unfortunates who are unable to communicate coherently at all, like the Americans. The best thing about emojis is that they are standardised, cross-platform and strictly controlled. That means they are free from the influence of advertisers. When Durex proposed a

condom emoji to promote safe sex, it had to be generic, with no branding whatsoever. I'm assured that the fact the condom emoji is blue is completely non-political.

This is all a boon to the electronic generation, freed from the crossed wires and misinterpretation that social taboos and sexual tension once caused when silly old words were the fashion. Even seduction by text message was a risky business, mostly caused by predictive text, inviting people to Fukushima. But with emojis, there can be no doubt, and thanks to single-button functionality what once took ages to express can now be achieved in a few clicks. Only last week, a close relative achieved intimate congress thanks to the following emojis: [beer] [wine] [wink] [banana] [no-entry] [condom] [thumbs-up] [fish].

The inclusion of facial emojis is also a wonderful way to show our feelings. In the past, we had to invest our time looking at one another and trying to interpret the 42 muscles of the human face. What misery.



Now, any feeling can be expressed in one click and recognised in a second. There are 98 emojis that currently represent faces, which is probably all anyone will ever need. All the female emojis are blonde, of course, because only blondes can talk. I am also delighted to see nine emojis aimed at cat communication – 10 if you include Unicode U+1F4A9 which represents a smiling turd.

I do hope the terrorist community will also adopt emojis as a means to threaten us, instead of making all those tiresome and distasteful videos that go on for ages. ISIS could get its message across with a simple: [beer] [angryface] [pig] [angryface] [music] [angryface] [man] [kiss] [man] [angryface]. Their black flag emoticon U+1F3F4 was approved as part of Unicode 7.0 in 2014, so they did better than Durex on that one. I can hardly wait for all communication to be expressed by emojis so I can finally make my own feelings absolutely clear to the people of the world: [pen] [yawn] [middle finger] [dollar sign]. ☹

CES®

2016

THE HIGHLIGHTS

IN JANUARY, Las Vegas opened its doors to CES, the biggest technology show of the year. There we had our first glimpse of all the new and exciting gadgets that will arrive in 2016. These are our highlights from the show floor.

OLED ARRIVES ON LAPTOPS

So far, OLED screens have been confined to TVs and smartphones, but Lenovo is bringing the technology to its brand new ThinkPad X1 Yoga business laptop. Compared to an IPS display, the difference in image quality is huge, but Lenovo warned that the OLED version would potentially take a bit of a hit when it came to battery life, with 11 hours predicted for the IPS version, but only nine hours for the OLED model.

The other big change to Lenovo's business line-up is that the keyboard now flips around 360°, allowing you to use it in laptop mode, tent mode, stand mode or as an absolutely enormous tablet. The keys retract into the base for this last mode, so the rear feels flatter in the hand. At 14in and 1.27kg, though, it's probably more suited to using on your lap.



Lenovo's new ultra-portable business laptop has a gorgeous 14in OLED 2,560x1,440 display



↑ Panasonic's DMP-UB900 is the company's first 4K Blu-ray player and will be out later this year

With Intel's latest Skylake processors and HD Graphics 520 chips, up to 16GB of RAM and a 1TB SSD, the ThinkPad X1 Yoga will be a formidable ultra-portable when it launches this month, but it won't come cheap, with US prices starting at \$1,449 (around £1,022).

4K BLU-RAY IS FINALLY HERE

It's been a long time coming, but 4K Blu-ray is finally on its way. The UHD Alliance (UHDA), an inter-industry group made up of companies including Samsung, LG, Netflix and several major Hollywood film studios, kicked off CES this year by announcing it had finally nailed

down an official specification for 4K Blu-ray, along with a new logo to help consumers identify which products and services will deliver the very best 4K has to offer.

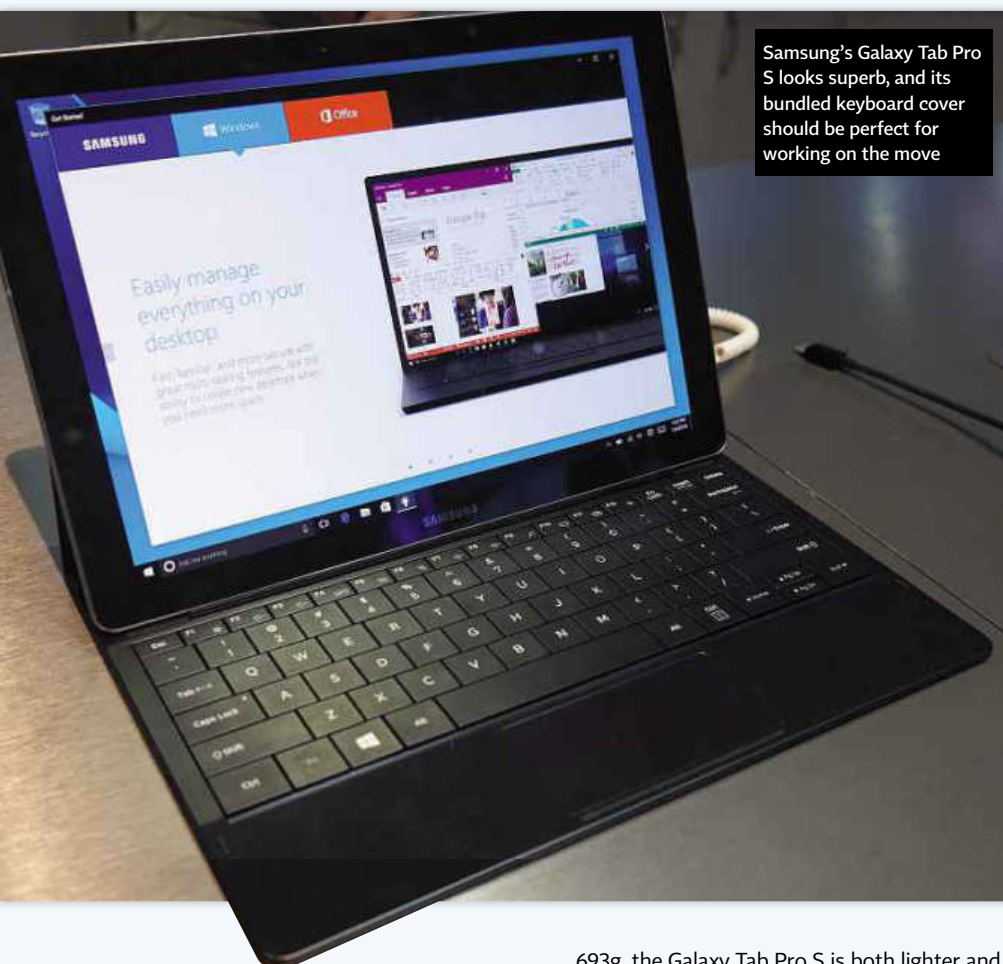
The UHD Premium logo will be reserved for products and services that meet the UHDA's exacting performance metrics for resolution, high dynamic range (HDR), brightness, black levels and colour gamut. The specification also makes recommendations for immersive audio, and covers multiple display technologies, so you should see the logo appear on both LED and OLED-based TVs.

Unsurprisingly, Samsung was one of the first companies to announce that its entire range of 2016 SUHD TVs would be certified for the UHD Premium logo, with LG quickly following suit, with all its 2016 OLED TVs getting the UHD Premium logo as well.

Panasonic is also on board, as it announced that its new flagship DX900 4K LED LCD TV would be the first TV in the world to meet the UHDA's specification. It uses a new VA-based LCD panel and has a direct-lit LED backlight accompanied by full-array local dimming. Panasonic said it will have 512 independent dimmable zones, allowing it to produce the high luminance levels and low blacks required by the UHD Premium standard.

More importantly, Panasonic finally showed off its first 4K Blu-ray player, the DMP-UB900. With support for HDR, the BT.2020 wide colour gamut, high-resolution audio and 7.1-channel audio, as well as a twin-HDMI arrangement, the UB900 will also be getting a UHD Premium logo on its box when it launches later this year.

Samsung, meanwhile, announced that pre-orders for its first 4K Blu-ray player are now open to customers in the US. Originally unveiled at IFA last year, the UBD-K8500 will



Samsung's Galaxy Tab Pro S looks superb, and its bundled keyboard cover should be perfect for working on the move

be available for \$400 in March, with the UK hopefully to follow shortly afterwards.

Sony is going its own way, but that doesn't mean its 2016 TVs aren't worth your attention. Topping the range is the XD93, which uses Sony's brand-new Slim Backlight Drive technology to deliver first-class picture quality while still keeping the TV's dimensions down to almost OLED-sized proportions.

Available in 55in and 65in screen sizes, the XD93 uses a grid-array backlighting system to boost and dim the backlight to create brighter whites and deeper blacks, producing up to three times the brightness range of the average LED TV. Sony still needs somewhere to house the bulk of its hardware, so the XD93 is a fraction fatter towards the lower half of the screen, but it's still slim enough to lie almost completely flush against the wall if you don't want to use the stand.

The XD93 supports HDR and is powered by Android TV, so you'll be able to access most of your favourite Google Play apps on the big screen. The XD93 doesn't have an exact price or release date just yet, but Sony expects it to launch across Europe later this spring.

SAMSUNG TAKES ON MICROSOFT

Lenovo wasn't the only company showing off its latest Windows 10 devices, as Samsung announced its first Windows 10 tablet, taking direct aim at Microsoft's Surface Pro 4. Measuring just 6.3mm thick and weighing

693g, the Galaxy Tab Pro S is both lighter and slimmer than the Surface Pro 4, and it will also be the company's first Windows device to come with a Super AMOLED display.

Admittedly, its 12in screen and 2,160x1,440 resolution isn't quite as large or as detailed as Microsoft's, but it does come with a full-sized keyboard cover – something that prospective Surface Pro 4 owners have to buy separately.

Inside, the Galaxy Tab Pro S has a sixth-generation dual-core Intel Skylake Core M processor which runs at 2.2GHz and 4GB of RAM, and its 5,200mAh battery should provide up to 10-and-a-half hours of battery life.

The only downside is its lack of ports, but Samsung says that a multi-port adaptor, which includes HDMI, USB and USB Type-C connections, will be available separately. Samsung has yet to announce official pricing for the Galaxy Tab Pro S, but it

will be available globally this month.

SUPERSIZED HUAWEI

Most manufacturers save their big phone announcements for MWC in February, but Huawei took the opportunity at CES this year to reveal its next phablet, the Mate 8. It has a massive 6in screen, but surprisingly Huawei has opted for a 1,920x1,080

resolution rather than the more common 2,560x1,440 we often see on big-screen phones. Still, with a pixel density of 367ppi, it should still provide plenty of clarity at a normal viewing distance.

The Mate 8 will be the first phone to use Huawei's proprietary octa-core Kirin 950 chip, which is meant to be 30% more efficient than its old Kirin 930 chip. Another improvement comes from Huawei's redesigned fingerprint sensor, which has a shallower contact area to help increase the speed and accuracy of its recognition software.

For the rear camera, there's a 16-megapixel Sony sensor along with optical image stabilisation support and a dual-tone flash, and the 4,000mAh battery should provide up to 17 hours of HD video playback. The Mate 8 will ship with Android 6.0 Marshmallow out of the box, but the downside is that it comes with Huawei's Emotion UI, so don't expect a pure Android experience like the Nexus 6P.

The base model will cost €599 (around £460) when it launches later this year, but a UK release date is yet to be confirmed.

NIKON DOES A 360

Every year CES turns up a few unexpected releases from otherwise predictable but worthy manufacturers. A contender for this year's most-unexpected award is definitely the Nikon KeyMission 360, Nikon's very first action camera. At present, most 360° rigs are either too bulky or unsuited for extreme sports, but the tiny KeyMission 360 is packed with features.

With two fisheye lenses, a 4K resolution and electronic stabilisation, it's a big step-up from other all-in-one 360° devices, and it's pretty tough, too, as it's both dust- and shock-proof up to drops of two metres, and it can be used underwater up to 30m without the need for separate housing. It has Wi-Fi, Bluetooth and NFC as well, so expect easy pairing with a smartphone and easy control over shooting.

The KeyMission 360 will be the first in a whole line of action cameras from Nikon and will launch in the spring. There's no word yet on price, but it's certainly a serious-looking device with an impressive specification.



The UHD Premium logo will start appearing on products and services that can deliver the very best 4K content



Nikon's tiny action camera has dual fisheye lenses and can be used underwater up to 30m without additional casing

Microsoft's cheapest Surface Book will cost £1,299

MICROSOFT'S VERY FIRST laptop, the Surface Book, finally has a UK price and release date. Originally unveiled last October at Microsoft's Windows 10 event, the device is arguably one of the most impressive laptops we've ever seen, but with prices starting at a massive £1,299, you'll need to dig deep into your bank account before you can call one your own.

Pre-orders for the Surface Book are now live on the Microsoft Store and four models are available, all shipping by the 18th February 2016. The £1,299 model comes with an Intel Core i5 processor, 8GB of RAM and 128GB of storage, but you can also get the same spec with 256GB of storage and a dedicated Nvidia GPU for £1,599.

Core i7 models are even more expensive, with the 256GB of storage, Nvidia GPU and 8GB of RAM model costing £1,799, and the top-end 512GB of storage and 16GB of RAM model costing a whopping £2,249.

That makes it a lot more expensive than Microsoft's Surface Pro 4, but the Surface Book is a lot more attractive than its tablet-based



Want one of Microsoft's new Surface Book laptops? Start saving now

sibling. Its silver magnesium body and caterpillar-like Fulcrum hinge look stunning, but the fact that you can pull it apart and use it as a standalone tablet as well is just the icing on the cake. We're hoping it will finally give Windows 10 the flagship device it deserves, but we'll bring you our full and final verdict as soon as review samples arrive.

AMD unveils new Polaris GPU architecture

AMD HAS ANNOUNCED its latest GPU architecture for 2016. Code-named Polaris, it features several new features, which AMD says should deliver a "historic leap in performance-per-watt".

Using a 14nm FinFET GPU as well as AMD's fourth-generation Graphics Core Next (GCN) architecture, Polaris should deliver a huge step-up in overall power efficiency, meaning higher performance levels at a much lower cost. Previously, AMD has used a 28nm production process, but FinFET's smaller '3D' transistors will allow each chip to take up less space, use less power and increase performance.

To put that into perspective, AMD said that one of its unannounced Polaris GPUs will draw just 84W when running Star Wars: Battlefront at 1,920x1,080 at 60fps, compared

it's been designed for 1080p gaming, VR and multimedia applications running on small form-factor "thin and light computer designs", which will be particularly good news for those who like to play games on the go.

The Polaris architecture also comes with HDMI 2.0a and DisplayPort 1.3 support, and its media capabilities will receive a significant boost with 4K H.265 encoding and decoding, promising 4K resolutions at a smooth 60fps.

AMD expects its first Polaris GPUs to start shipping from the middle of this year, just in time for it to compete with Nvidia's new GPU technology, currently code-named Pascal.



to Nvidia's GeForce GTX 950 card which requires 140W under the same conditions.

We should see the benefit of Polaris in both desktops and laptops alike, as AMD says

Oculus Rift to launch in March for £499

OCULUS HAS FINALLY announced the price and release date for its virtual-reality headset, Oculus Rift. Launching on 28th March, the Rift will set you back £499 plus shipping costs.

Pre-orders for the headset opened at the start of January, but it took just 80 minutes for the first wave of headsets to sell out, pushing subsequent shipping dates back to May, then June, and now July at time of writing.

There's a limit of one headset per customer, but those who pre-order now get two games for free: CCP's EVE Valkyrie, a 360° space shooter, and Lucky's Tale, a 3D platformer about the adventures of a cartoon fox.

At £500, the Oculus Rift is a lot more expensive than we were expecting

In the box you get an Xbox One controller, the headset with built-in headphones and mic, the camera sensor and the Oculus Remote. The Remote is a new input device which will let you browse apps including the Oculus Store, view 360° videos, and even play games.

If you pre-order an Oculus Rift you'll also secure a place to pre-order Oculus's motion-tracking Touch controllers when they launch later this year. So far, Oculus has only said they will be released in the second half of 2016, with pre-orders going live a few months prior to launch. There's currently no word on how much they will cost, but given the price of the headset we wouldn't be surprised if they were at least £100.

At the moment, the Touch controllers aren't an essential purchase, as all games will be playable with the bundled Xbox One controller. However, for those who want a fully immersive VR experience, the Touch controllers might be worth considering, as they can track your hand movements in 360°, allowing you to manipulate objects, reach out and make life-like hand interactions in real time.

Oculus also announced that it will begin selling Rift headset and Oculus-Ready branded PC bundles this month, with prices starting from £1,499, providing an easy, if expensive, way for people to make sure their PC will be able to run games on the Rift once it arrives.



Lenovo to phase out Motorola brand

MOTOROLA HAS PRODUCED some of the best smartphones we've seen over the past three years, most notably the superb Moto G, which has consistently beaten every other budget smartphone on the market since it was introduced in 2013. However, Motorola's chief operating officer Rick Osterloh announced last month that the Motorola brand will be disappearing from its handsets over the coming year as it starts to unify its smartphone business with its parent company, Lenovo.

"We'll slowly phase out Motorola and focus on Moto," Osterloh said during an interview with CNET at CES.

Lenovo bought Motorola from Google in 2014 and until now has kept Motorola's logo and Moto branding on all of Motorola's smartphones. This will still be the case for Motorola's high-end devices, but Osterloh stated that its budget devices will soon be rolled into Lenovo's Vibe brand. The Motorola name will also live on as a corporate division of Lenovo, but even Motorola's flagship devices will start bearing the name "Moto by Lenovo".

"Motorola Mobility continues to exist as a Lenovo company and is the engineering and design engine for all of our mobile products," a spokesperson for Motorola UK told *Shopper*. "However, for our product branding we will utilise a dual-brand strategy across smartphone and wearables using Moto and Vibe globally. 'Motorola' hasn't been used on our products since the original Moto X in 2013."

The news comes as a surprise after Lenovo's CEO Yang Yuanqing said it would "not only protect the Motorola brand, but make it stronger" when Lenovo first bought the company two years ago.

According to Osterloh, it won't be long before we start seeing Vibe phones on shop shelves, as he will be taking over all mobile operations at Lenovo very soon. Where Lenovo has a strong market presence, it will use its connections to push Moto-branded phones as aspirational devices, but it will rely on the strength of Motorola to begin introducing sub-\$100 Vibe smartphones where it has a weaker presence.

"It didn't make a lot of sense not to cover the markets, top to bottom," he told CNET.

Osterloh also said he expects to take Vibe smartphones to the US at some point, but it's unlikely to happen this year. This suggests we might still get one last Moto G before it disappears forever, but Motorola UK told us it cannot comment on any product-related questions for the time being.



Its launch is a few months away, but HTC has announced a second Vive dev kit with a new front camera

HTC adds front camera to Vive VR headset

HTC HAS UNVEILED a second-generation developer edition of its Vive VR headset. Known as the HTC Vive Pre, the new headset has an all-new front facing camera, improved room-scale technology and a lighter, more ergonomic headset and controller design.

According to HTC, "each and every component has been redesigned from the ground up to provide better comfort, ergonomics and performance", including a more compact headset and a brand-new strap design to provide greater stability and better balance. This includes the ability to adjust the size of the headset to suit different types of faces and, more importantly, being able to fit it over glasses.

The display is also brighter, with HTC saying it's made "image refinements" to help increase clarity and sense of presence.

Another new addition to the Vive Pre is a front-facing camera, which lets users see certain parts of their physical environment without having to remove the headset. It's not quite clear how the Vive Pre will "blend physical elements into the virtual space", but HTC says you'll be able to find your seat, drink and carry on conversations with family members while still being immersed in virtual reality.

The Vive's controllers have been redesigned for the Pre, with softer edges, updated ergonomics and new textured buttons and grip pads for comfort. The new dual-stage trigger should make object interaction much smoother, while haptic feedback should add that extra layer of immersion. The controllers' rechargeable batteries charge via Micro USB to provide four hours of play time, and the base stations have been redesigned to be more compact, quieter and provide better tracking.

"When we announced Vive 10 months ago we had an ambitious goal of fundamentally changing the way people communicate and interact with the world – forever," said Cher Wang, CEO of HTC.

"Since then Vive has received a phenomenally positive reception from media, industry commentators, consumers, and the partners and brands we've been working with to deliver inspiring and dynamic VR content. For too long, the promise of virtual reality has been little more than a promise. Today we stand on the precipice of a new era. Vive is creating a world where the only limit is human imagination."

Originally scheduled to launch at the end of 2015, the final version of the Vive is now expected to launch in April 2016.



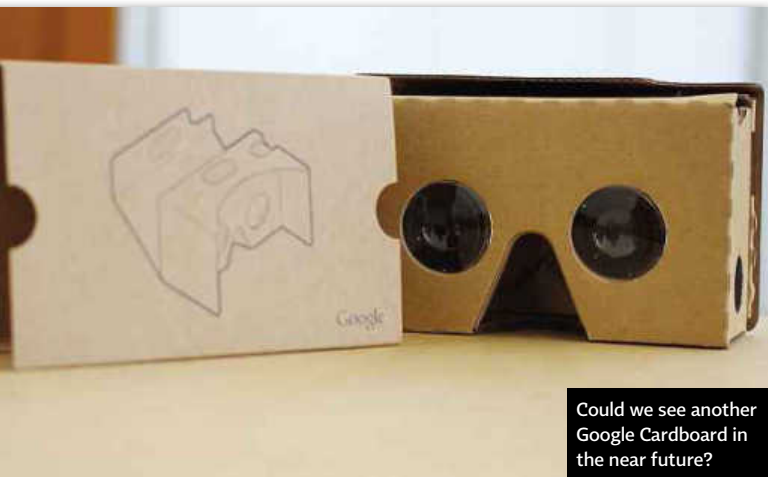
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Could we see another Google Cardboard in the near future?

Google to open VR division

COMPARED TO THE heavy investment by Facebook, Sony and Microsoft in virtual and augmented reality, Google has kept relatively detached from the high-end VR headset market. That now looks set to change, as reports suggest parent company Alphabet will be opening a dedicated virtual-reality division and selecting a new VR boss.

Citing a number of sources familiar with the matter, the US tech website Re/code claims that Google CEO Sundar Pichai has chosen vice-president for product management Clay Bavor to head up the VR arm. That looks to be the case, as Bavor has now changed his Twitter profile to read "VP, Virtual Reality at Google".

The move signals a clear shift in Google's approach to virtual reality, as its current contribution to the technology has extended only as far as the Google Cardboard viewer. This ultra-cheap do-it-yourself viewer aimed to make VR accessible to a larger market, but with the Oculus Rift now firmly on the horizon, the VR and AR race looks to have moved up a gear.

Re/code points out that the move could be connected to continuing investment in augmented-reality firm Magic Leap, which Google acquired in 2014. Whatever the case, it shows Google reacting in a big way to the imminent wave of virtual-reality devices set to arrive over the coming months.

Netflix to clamp down on proxy viewers

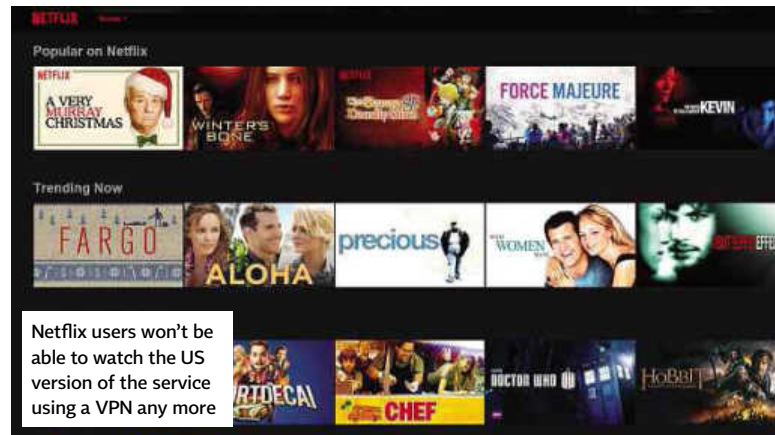
NETFLIX IS TO get tough on viewers who use proxy servers to access shows available in other countries. In a blog post titled "Evolving Proxy Detection as a Global Service", vice-president of content delivery architecture David Fullagar claimed that the next few weeks would see the rollout of new measures targeting virtual private networks (VPNs).

"In coming weeks, those using proxies and unblockers will only be able to access the service in the country where they currently are," wrote Fullagar. "We're confident this change won't impact members not using proxies."

The company didn't explain how it intends to block VPNs, but it could simply be a matter of blocking IP addresses tied to proxy servers.

Elsewhere in the post, Fullagar acknowledged that proxy servers wouldn't be necessary if the content was available globally. "We are making progress in licensing content across the world and, as of last week, now offer the Netflix service in 190 countries, but we have a ways [sic] to go before we can offer people the same films and TV series everywhere," he wrote.

"Over time, we anticipate being able to do so. For now, given the historic practice of licensing content by geographic territories, the TV shows and movies we offer differ, to varying degrees, by territory. In the meantime, we will continue to respect and enforce content licensing by geographic location."



Chrome speeds up with new algorithm

GOOGLE HAS ANNOUNCED that it will be rolling out a new compression algorithm to its Chrome browser in the near future, boosting speeds by up to 26%.

The so-called Brotli technology will compress data, including font compression

and other intensive elements commonly sent to and from pages, to make them load faster. It replaces the previous Zopfli algorithm Google was using to cut down the volume of traffic throughput, which was released two years ago.

Google explained that the compression engine will have two other benefits for mobile users: it will reduce data transfer levels and cut battery usage.

Following the success of open-source algorithm Zopfli, the technology was adopted by a number of other companies to compress data traffic, including PNG optimisers and pre-processing web content engines. Google is hoping the same will happen with Brotli.

Zoltan Szabadka, software engineer for Google's Compression Team, said: "The smaller compressed size allows for better space utilisation and faster page loads. We hope that this format will be supported by major browsers in the near future, as the smaller compressed size would give additional benefits to mobile users, such as lower data transfer fees and reduced battery use."



Google's new Brotli algorithm will be particularly beneficial for mobile Chrome users, as it will cut battery usage and reduce data transfer levels

BT and EE merger gets official go-ahead

BT'S BID TO buy mobile telecoms group EE for £12.5 billion has been cleared by the Competition and Markets Authority (CMA), bringing together the UK's largest fixed-line telephone company and the largest mobile telecoms business. The merger will finally allow BT to deliver a full 'quad-play' service, offering fixed-line telephone, mobile, broadband and television deals similar to Virgin Media and TalkTalk.

It also means that BT will own a worryingly large share of the market. It already controls 31% of the fixed-broadband market, according to Ofcom figures, as well as 37.6% of home phone traffic. This merger will add EE's 33.8% share of the mobile sector to the company's already inflated portfolio.

The merger of Orange and T-Mobile which birthed EE in 2010 saw the company take an immediate and commanding market lead. EE has dominated the industry to the extent that in the 2012 auction of 4G spectrum bandwidths, Ofcom had to step in to prevent smaller companies such as Three from being muscled out altogether.

John Wotton, chair of the CMA inquiry, said he didn't have any concerns about the effect on competition. "The evidence does not show that this merger is likely to cause significant harm to competition or the interests of consumers," he said.

The merger could potentially see huge savings for customers, but there have been ongoing concerns about the state of each company's Ofcom customer satisfaction ratings. Both BT and EE are ranked lowest for customer service in their respective fields.

In BT's case, Ofcom said that the company's satisfaction rate was "significantly lower than average". It added: "[BT] also performed below average on specific customer service measures including speed and ease of getting through to the right person, time taken to handle issues and offering compensation or a goodwill payment."

BT previously admitted that it struggled to cope with the rush of customers following the launch of BT Sport. Attempting to integrate EE's 24.5 million subscribers with its existing services could present it with a similar scenario and put BT's already stretched customer service department further to the test.

BT first announced its merger with EE in December 2014, and the deal has now finally been cleared by the authorities



Amazon's new credit scheme will make it easier to stagger payments, but you could end up paying much more overall

Amazon UK to offer credit – at a cost

LAST YEAR, IF you wanted to spend a lot of money at Amazon, you'd be charged the entire lump sum in one go. Now the retail giant has announced a new loan scheme in collaboration with Hitachi Capital, meaning that your money will be taken in smaller, less painful increments over a period of up to four years.

There are caveats, of course. The first is that the loan is subject to an APR of 16.9%, meaning you're paying considerably more for the convenience of staggered payment. If, for example, you were buying a £2,000 TV, you'd end up paying a total of £2,765 over four years.

It's also only available for items sold and dispatched by Amazon, meaning third-party goods won't qualify for the pay-monthly option. You need to spend at least £400 to qualify for 24-month repayments, £750 for 36 months and £1,000 for 48 months, and the cost can be spread across your basket, so you don't have to spend it all on one item.

There's no deposit involved. Instead, the first payment is the first of your monthly instalments. Simply select the financing option at the checkout for a qualifying order, and then see if you pass the credit checks for a loan of one to four years.

Hitachi Capital already provides a similar service for John Lewis. Gerald Grimes, the managing director of Hitachi Capital Consumer Finance, told *The Guardian*: "Our new trial with Amazon is all about giving people the fastest and most seamless experience when it comes to point-of-sales credit."

"Amazon is famous for its '1-Click' service, allowing you to place an order at the click of a button with pre-stored payment details and delivery addresses. This is part of boosting that customer experience and could signal huge changes for the online retail industry."

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4K Blu-ray

Everything you need to know

We're finally going to see 4K films in our homes thanks to a major overhaul of the Blu-ray format, with discs and players arriving this year

THE TV IN your living room is probably a Full HD model with around two million pixels, and very nice it looks, too. However, when you go to the cinema you're watching films projected with a whopping eight million pixels. Ultra HD Blu-ray is a new standard for discs that will bring cinema-quality films into your home. And the difference in visual quality is startling.

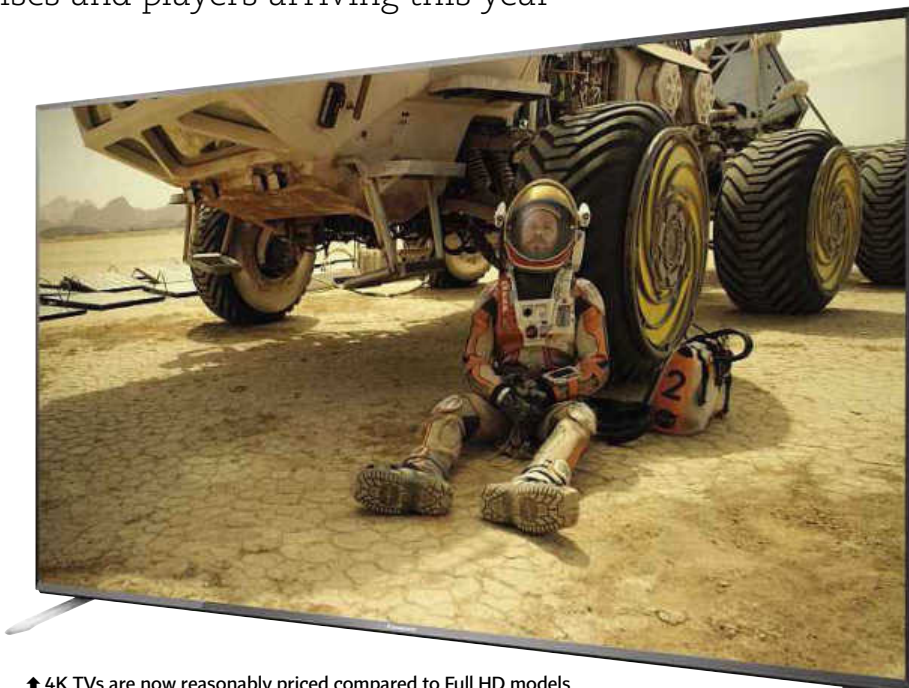
This guide will discuss what kit you'll need to watch these new high-detail movies and what TVs and players are available today. We'll also look at the various films and discs that are set for release at launch. And finally, we'll discuss in more technical detail the differences between the current Blu-ray format and the new Ultra HD standard.

4K OR ULTRA HD: CONFUSED?

4K and Ultra HD are often used interchangeably, which can be confusing, so let's nip this one in the bud first. 4K is the current standard for digital cinema projection; the vast majority of films in the UK are now shown in this format. When you go to the cinema you're watching a film with a 4K resolution of 4,096x2,160 pixels.

Ultra HD is the consumer standard for TVs. This has a slightly different resolution of 3,840x2,160 pixels, which is exactly four times that of the current Full HD standard (1,920x1,080). Many manufacturers refer to their TVs as being 4K, when in reality they all have this slightly lower resolution.

With so many pixels, the difference between 4K and Ultra HD is negligible in terms of detail. However, 4K has a slightly more widescreen aspect ratio at 1.9:1, rather than Ultra HD's 16:9. This means that 4K films transferred to Ultra HD will have to use slender black bars at the top and bottom of the screen, or have the edges sliced off; the choice will be made on a film-by-film basis by the production studio.



▲ 4K TVs are now reasonably priced compared to Full HD models

With this exception, the two terms are practically interchangeable and manufacturers of kit and discs are generally using both. The new discs are officially called Ultra HD Blu-ray, but they all have '4K' written on them too, just in case you're more familiar with that term.

WHAT DO I NEED?

To watch Ultra HD Blu-rays in your home, you'll need three things: an Ultra HD TV, an Ultra HD Blu-ray player and an Ultra HD Blu-ray disc to play on it.

4K/Ultra HD TVs were laughably expensive at the beginning of last year but have since plummeted in price, leaving anyone who bought in early feeling pretty sick. You can buy such a TV from as little as £450 today, so it's well worth paying the extra over a Full HD set. Check that your chosen TV has

both HDMI 2.0 and HDCP 2.2 connections in order to work with the Ultra HD Blu-ray standard; most sets have these, but if you see a bargain then look closely at the specs before buying.

No current Blu-ray player or games console can play the new Ultra HD Blu-ray standard. That means you'll need a new player in order to play the new discs plus, of course, you'll need some Ultra HD Blu-ray films to play on it.

WHAT PLAYERS ARE AVAILABLE?

No players are presently available in the UK, and we're still awaiting release dates. Samsung has announced the Ultra HD Blu-ray Player (UBD-K8500), which it demoed in September 2015 at the IFA show in Germany. Although that may point to an imminent European release, to date it's only been available for pre-order in the US, where it will cost \$400. Samsung will start shipping players to US customers in March.

Panasonic has also shown off a player, the Ultra HD Blu-ray player DMP-UB900. This looks to be a top-end model, with dual HDMI outputs and lots of extra features aimed at audio enthusiasts. We're not convinced any of that is really necessary, but it's still bound to push up the price of the player. Rumours are it will cost under £700, but not by much.





The Philips BDP7501 is among the first players and has a smart, compact design

At CES (see page 16), Philips announced its own player, the Premium Compact Design 4K Ultra HD Blu-ray player BDP7501. This breaks away from the usual hi-fi component format for something that's only as big as it needs to be – a change we applaud but which might not sit well with those who like their AV racks of same-sized kit. The player will cost US\$399 and is scheduled for a May 2016 launch; there's no news yet on a UK release.

Technically speaking all the players here essentially do the same job: they play Ultra HD Blu-ray discs. They all support high-

Warner Bros has promised to release 35 titles before the end of 2016. The first titles to be made available will be *Mad Max: Fury Road*, *San Andreas*, *The Lego Movie* and *Pan*. Of those, *Mad Max* and *Lego* will probably sell the most.

20th Century Fox is planning on releasing 100 movies by the end of the year. Initial releases will include *Exodus: Gods and Kings*, *Kingsman: The Secret Service*, *Fantastic Four*, *X-Men: Days of Future Past*, *Life of Pi*, *The Maze Runner* and *Wild* – so there's something for most people there.

Transferring films to Ultra HD Blu-ray will be a doddle compared to moving celluloid movies to Blu-ray

dynamic range (HDR) for better colour depth and contrast and will all support streaming 4K services such as Netflix, although exact services are to be confirmed.

WHAT FILMS CAN I WATCH?

With many recent films shot in 4K and many more already mastered into the format for showing in digital cinemas, transferring them to Ultra HD Blu-ray will be a doddle compared to the trials and tribulations of moving celluloid movies to the original Blu-ray format upon its release. That means you can expect to see lots of Ultra HD Blu-ray films from the off and quality really shouldn't be an issue with the format. So who's announced what?

Sony is also releasing movies this year. Initial launches will include *The Amazing Spider-man 2*, *Salt*, *Hancock*, *Chappie*, *The Smurfs 2* and *Pineapple Express*, which isn't exactly a stellar line-up in our eyes

All these discs should be on sale by March, and many are already available to pre-order from Amazon.

HOW MUCH WILL DISCS COST?

Ultra HD Blu-ray discs are going to be more expensive than regular Blu-ray and even more expensive than DVDs. On Amazon.com in the US, *The Martian* is listed for \$30 (down from the RRP of \$40). By comparison, the regular Blu-ray version costs just \$15. That's four

times the pixels for the double the price, which we're not sure is a very good deal.

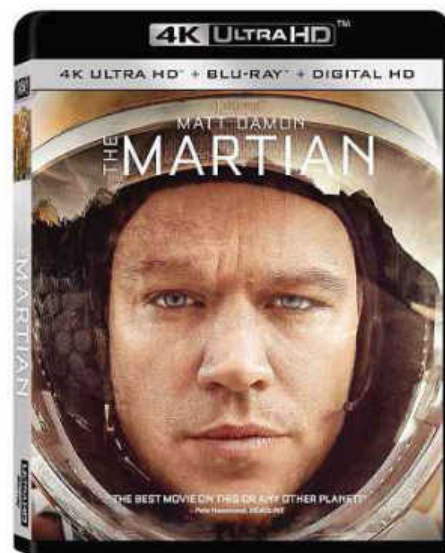
It's a similar story with the other launches, although some titles will ship with a regular Blu-ray copy and a digital edition as well. It's not uncommon for new formats to be more expensive than old ones: Blu-rays cost a lot more than DVDs when they launched.

In the case of Ultra HD Blu-ray, the price increase is likely to be because few people will have the ability to watch Ultra HD discs, so there'll be a smaller production run, reducing economies of scale. If Ultra HD Blu-ray really takes off, the cost of the discs is likely to drop rapidly, while multi-buy deals in most shops should help reduce the cost further.

CAN I BUY DISCS OVERSEAS?

It looks as though Ultra HD Blu-ray discs will be region free, with no geographic locking system currently being discussed. This means you can buy your discs from wherever you want and won't have to wait for UK releases. Don't rush off to Amazon.com yet, though, as we'll be confirming this nearer the release.

There will be copy protection, however, and documents purportedly from Sony have even hinted that some discs may require an internet connection to authenticate themselves on first being played. **CS**



↑ The new disc boxes are clearly marked with 4K and Ultra HD logos

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VERDICT

It's expensive, but the Dell XPS 15 is the best Skylake-based Windows 10 laptop you can buy today

IT'S HARD NOT to be wowed by Dell's slim InfinityEdge bezels, even if the feat of engineering is no longer anything new. Next to the razor-thin Dell XPS 13, however, even the slickest of laptops suddenly looks ungainly. This hasn't changed with the XPS 15, which takes much of what we loved about the XPS 13 and applies it to a much larger laptop.

With bezels measuring just 5.7mm, it's a beauty to behold and puts Apple's 15in MacBook Pro to shame. Both laptops weigh around 2kg, so neither is more portable than the other, but after opening the XPS 15's lid, we knew which one we'd rather be carrying.

Those super-slim bezels are complemented by a gorgeous aluminium chassis and carbon fibre composite keyboard and palm rest. Admittedly, the amount of space around the keyboard seems excessive compared with the neat, compact borders of the XPS 13, but the keyboard is sensibly laid out and offers plenty of space to rest your hands. The palm rest became slightly warm during day-to-day use but never uncomfortably hot.

The keys provide a respectable amount of travel and we were able to get close to around 80% of our top recorded typing speed



compared with a mechanical keyboard, which is pretty good for a laptop.

The large touchpad also makes good use of the space available, and responded beautifully to each stroke, tap and multitouch gesture. There are no dedicated buttons, but left and right clicks at the base of the touchpad worked without a hitch.

TO INFINITY AND BEYOND

All but the lowest-specification XPS 15 is equipped with a glossy 3,840x2,160-resolution display. That's a higher resolution than the 2,880x1,800 Retina panel on Apple's MacBook Pro, but those who are looking to save money with the lower specification will have to make do with a 1,920x1,080 non-touchscreen panel.

We tested the 3,840x2,160 InfinityEdge display, and to say it's stunning is a huge understatement. With 100% coverage of both the Adobe RGB and sRGB colour gamuts, the XPS 15 delivers true and accurate colours with aplomb. The panel reaches almost eye-searing brightness levels of 363.4cd/m² too, so you won't struggle if you're working outdoors.

We had to dial it down a few notches when using the laptop indoors, as our eyes became fatigued at maximum brightness. Black levels suffer slightly, as the screen's black measurement of 0.34cd/m² is fairly average. The same goes for its contrast ratio of 1,065:1, which is respectable but nothing special.

Under more subjective tests, the screen looks beautiful with plenty of sharp, crisp detail and vibrant colours. The reflective coating proved a little irksome under certain lighting conditions, but no more so than other reflective screens we've tested. Luckily, the XPS 15 lacks the XPS 13's adaptive contrast, so it's better for creative professionals.

The 3,840x2,160 models all come with touchscreens, which respond brilliantly to all manner of swipes and gestures. The laptop's hinge is strong and firm enough to withstand constant prodding, too.

To help make using such a high-resolution display easier, Dell's virtual monitor software can snap windows into different positions on





p26 | Acer Chromebook R 11



p33 | OnePlus 2



p38 | Google Pixel C



p44 | Samsung UE48JU7500



p60 | Rise of the Tomb Raider

the screen when you start moving them, so you won't have to maximise them or move them far across the display. It's particularly handy if you don't have any of the Windows 10 scaling options enabled, but we'd recommend turning on scaling to at least 150% to read text comfortably.

PERFORMANCE POWERHOUSE

The XPS 15 is available in numerous configurations, but our review unit came with a quad-core 2.6GHz Intel Core i7-6700HQ (with Turbo Boosting up to 3.5GHz), 16GB of DDR4 RAM, a 2GB Nvidia GeForce GTX 960M and a 512GB PCIe SSD.

No matter which spec you choose, every XPS 15 is competitively priced against Apple's 15in MacBook Pro with Retina display, especially as Apple is still using Intel's 4th generation Broadwell processors. We weren't surprised to discover that the XPS 15 performed brilliantly in our benchmarks. It earned an overall score of 111, achieving excellent scores across the board in our

and the XPS 15 even managed 31.6fps in Metro Last Light Redux at 1,920x1,080 with graphics set to Very High once we'd turned off the super-sampled anti-aliasing. Dropping down to Medium graphics in Metro Last Light saw a jump to 51.5fps, which is very impressive on a laptop like the XPS 15.

An SSD helps the XPS 15 boot up and shut down swiftly, and Windows 10 feels super-responsive, producing sequential read speeds of 1,525.51MB/s and write speeds of 541.54MB/s. Combine this with an immaculate screen and you have a superb system that can be used both for work and play.

The only disappointing part of the XPS 15 is its battery, which lasted just 5h 40m in our continuous video playback test. It's a far cry from Dell's advertised battery life of 17 hours,



use it with Dell's optional, yet-to-be-released Thunderbolt Dock, which will allow you to output to three displays at 1,920x1,080 or two displays at 3,840x2,160.

Without the dock, you have a full-size HDMI connection for an external display, two USB3 ports, an SD card reader and a headset jack. If you require an Ethernet port, you'll have to buy an optional USB Type-C to HDMI/VGA/Ethernet/USB3 adaptor. Alternatively, you can use the built-in 802.11ac MiMo Wi-Fi.

The Dell XPS 15 is a stunning laptop. It doesn't have quite the same visual impact as the diminutive XPS 13, but its marriage of high performance with stylish looks more than justifies its premium price. With this and the XPS 13, Dell has two shining lights that show off Windows 10 to its fullest. The XPS 15 is the ultimate Windows 10 laptop, competing with – and in many aspects overtaking – the 15in MacBook Pro. It wins a Best Buy award.

Richard Easton

With 5.7mm bezels, the Dell XPS 15 is a beauty to behold and puts Apple's 15in MacBook Pro to shame

image-editing, video-editing and multitasking tests, which puts it right up there as a viable desktop replacement.

Of course, its dedicated GeForce 960M graphics chip will never be able to compete with a proper gaming laptop, but if you're willing to compromise on image fidelity (and put up with its rather loud fans), you can get playable frame rates on even the most taxing games. Dirt Showdown at 1,920x1,080, 4x anti-aliasing and Ultra graphics ran at 45.1fps,

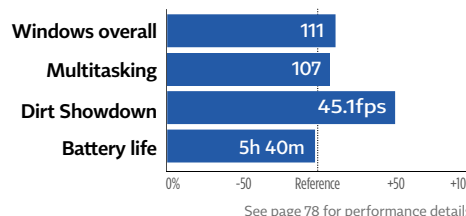
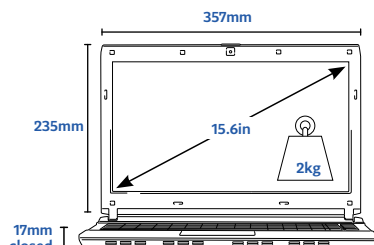
but considering how well-specified the system is, it's actually pretty reasonable compared with other 15.6in laptops we've tested.

BETTER CONNECTED

Like the Dell XPS 13, the XPS 15 has a Thunderbolt 3 multifunction port that can be used for charging, data transfer and connecting an external display. This uses the familiar USB Type-C connector, so it works fine with USB-C devices. You'll also be able to

SPECIFICATIONS

PROCESSOR Quad-core 2.6GHz Intel Core i7-6700HQ
RAM 16GB
DIMENSIONS 357x235x17mm
WEIGHT 2kg
SCREEN SIZE 15.6in
SCREEN RESOLUTION 3,840x2,160
GRAPHICS ADAPTOR Nvidia GeForce GTX 960M
TOTAL STORAGE 512GB SSD
OPERATING SYSTEM Windows 10 Home Edition
PARTS AND LABOUR WARRANTY One year next business day
DETAILS www.dell.co.uk
PART NUMBER CNX5503



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VERDICT

Minor touchpad issues aside, the Chromebook R 11 is a well-built bargain laptop

CHROMEBOOKS HAVE NEVER been what you'd call 'premium' laptops, so it's no surprise that manufacturers do everything they can to drive down costs. Design is often the most obvious casualty, but Acer's Chromebook R 11 bucks this trend with a genuinely attractive and robust-feeling laptop. Amazingly, it also packs in a 360° hinge and a touchscreen to turn it into a makeshift tablet.

The 11.6in chassis is about as refined as budget laptops come, with sharp edges, white matt plastic and a lid with a classy weave-textured pattern that elevates the R 11 above its Chrome OS-powered rivals. At 1.2kg, it's very portable, and not too heavy to use as a tablet. It's thin, too, at just 20mm.

It's a little wanting for ports, with just one USB2 and one USB3 port available. There's an HDMI port for connecting an external display, an SD card reader and a 3.5mm headset jack. There's no Ethernet port but it's kitted out with 802.11ac Wi-Fi for a faster, more reliable connection if your Wi-Fi network is up to it.

The keyboard spans nearly the full width of the chassis. Some users may take issue with the slim Return key but we had no issues with layout. Key presses have lots of travel, and the keys have a friendly chunky feel that stops long typing stints becoming arduous.

TASK MASTER

The top row of keys provides the standard Chromebook functions, including Back, Forward, and volume and brightness controls. The Task View button is particularly useful if you have multiple windows open, but we were disappointed that this button doesn't also split up your open tabs for easier access – after all, this laptop is built for the web.

The touchpad is a mixed bag. It's responsive for standard swipes, multi-fingered

scrolling and taps, but physical clicks require a little too much force. If you tend to opt for a physical click instead of tapping, you will take issue with the R 11.

The laptop is cool and quiet in operation, thanks to its fanless design and low-power 1.6GHz Intel Celeron N3050 processor. This dual-core chip is paired with just 2GB of RAM, so the R 11 is hardly a powerhouse, but it can handle media-heavy websites such as The Guardian without too much fuss.

We used the R 11 mainly for emails, Spotify, document writing and YouTube, and didn't find ourselves too constrained by its speed. It was only when we opened lots of Chrome tabs containing ads and multimedia elements that it started to show its limitations, but it quickly returned to normal speed once we'd closed the offending web pages.

It scored a middling 636.5ms in the SunSpider web-based benchmark, and 22fps in the demanding WebGL 3D Cubes benchmark, which is respectable for a budget laptop. In JetStream, the challenging web-based benchmark, the R 11 managed a score of 47, which is a reasonable result.

As is always the case with Chrome OS, you'll have to commit to a life of cloud-based storage and web-based applications to get the most out of the R 11. Its very limited 16GB of onboard storage means you'll be transferring photos from your camera straight to the cloud, bypassing local storage entirely, which is something else to get used to.

The line-up of basic apps is strong, though. With Google Drive and its various productivity tools, plus Gmail, Polarr, YouTube, Spotify and Netflix available, it's easy to forget you're working in the cloud as long as you have a good internet connection. Google's offline Drive apps are also on hand if you happen to be in a Wi-Fi dead spot. The R 11 can last all day on a single charge, too, managing 8h 42m in our test, which is a great result for such a small laptop.



As with Lenovo's Windows-based Yoga laptops, such as the Yoga 700 (see p28), the R 11's 360° hinge design may have limited appeal depending on whether you want a standard laptop or one that doubles as a tablet. We were rarely tempted to switch to tablet mode, but that's largely because we prefer using a more precise cursor and keyboard. Chrome OS isn't really optimised for touch control either, although now that most major websites are easy to navigate with a prod of the finger, you shouldn't have any problems online. There's also an onscreen keyboard for entering passwords and the like.

TOUCHING DISPLAY

The 11.6in display is bright at 226cd/m², and its 1,366x768 resolution is acceptable, both for the size of the screen and the price. Text is perfectly legible and icons are large enough to tap easily on the touchscreen. The IPS panel doesn't serve up the deepest, most vibrant colours with its sRGB colour gamut coverage of just 66%, but it still holds its own, thanks in part to its 1,210:1 contrast ratio.

The Acer Chromebook R 11 is the most attractive and practical budget Chromebook you can buy today. It may not have the power or the best screen for intense multitasking, but it's a seriously good piece of kit for the money. The Asus C201 Chromebook costs around £40 less and its battery lasts a few more hours, but it lacks the R 11's exceptional build quality, processing grunt and IPS screen.

Michael Passingham



SPECIFICATIONS

PROCESSOR Dual-core 1.6GHz Intel Celeron N3050 • **RAM** 2GB • **DIMENSIONS** 20x295x203mm • **WEIGHT** 1.2kg • **SCREEN SIZE** 11.6in • **SCREEN RESOLUTION** 1,366x768 • **GRAPHICS ADAPTOR** Intel HD Graphics • **TOTAL STORAGE** 16GB eMMC • **OPERATING SYSTEM** Chrome OS • **WARRANTY** One year RTB • **DETAILS** www.acer.co.uk • **PART CODE** ND.20411.07Q



See page 78 for performance details

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CONVERTIBLE LAPTOP

LENOVO Yoga 700 (11.6in)



£560 inc VAT • From www.lenovo.com

VERDICT

Lenovo's convertible Yoga 700 is a very versatile laptop, but its display and keyboard let it down

CONVERTIBLE LAPTOPS HAVE been around for a while now, but few have found the right balance between price and performance. At £560, Lenovo's latest shape-shifting Yoga 700 falls into the mid-range category, but it still misses the mark for overall value.

Lenovo has actually made two Yoga 700 laptops – the 11.6in model we review here and a larger, more powerful 14.1in version. Otherwise, they share the same design and are available in a range of colours, including silver, white and an eye-catching orange.

Like previous Yoga laptops, the Yoga 700 has a special hinge that lets you fold it back on itself and use it as a tablet. You can also use the Yoga 700 in what Lenovo calls tent mode – an inverted V-shape that's handy if you want to prod at the touchscreen without holding it for long periods of time.

This makes the Yoga 700 incredibly versatile. The screen doesn't detach from its keyboard base, though, so you can't shed the excess weight when you switch to tablet mode. It's reasonably light at 1.1kg, but you'll soon get tired if you hold it in one hand for long. With a thickness of 16mm, it's not the slimmest laptop around, either.

STIFF JOINT

Soft-touch material on the outer lid and base makes the Yoga 700 easy to pick up and hold but the lid flexes a little too much for our liking. Otherwise, it's well put together, with a solid hinge that stays in whichever position you choose. You might struggle to find the small power and volume buttons, which are flush with the case, but at least you can use the keyboard's volume controls as a back-up when you're not using the system as a tablet.

For peripherals, the laptop has two USB2 ports and one USB3 port. Ideally, we'd prefer more of the faster USB3 ports, especially as one of the USB2 ports doubles as the power

connector, leaving one less port when it's plugged in. You can connect an external display using the Micro HDMI port, and there's also an SD card reader and headset jack.

The keyboard is another source of irritation. Not only do its keys lack travel, but its half-height Enter and reduced-width Left Shift keys were particularly irksome during prolonged use. The small touchpad wasn't much better. It handled most multitouch gestures well but occasionally missed an input, which became more frustrating the longer we used it. Thankfully, the touchscreen was far more responsive.

The display's 1,920x1,080 resolution is unusually high for a laptop of this size, but the quality of the screen itself was disappointing. The backlight bleeds from the bottom corners and the screen ripples and distorts when you exert any pressure on it. This is exacerbated by the flexible lid, which is something you certainly don't want on a touchscreen.

Colour accuracy left a lot to be desired, with sRGB coverage of just 61.6%, so this isn't a laptop to use for colour sensitive work. The screen's peak brightness of 335.1cd/m² is good, but its black level of 0.36cd/m² is average for a laptop of this price. The same goes for its mediocre contrast ratio of 744:1.

The 11.6in Yoga 700 has an Intel Core M3-6Y30 processor, which runs at 900MHz but can Turbo Boost up to 2.2GHz, and 8GB of RAM. With a benchmark score of 47, the Yoga 700 is more than capable of everyday tasks, but it was dragged down by a multitasking score of 31, so anyone who wants to run

several demanding applications at once will find their patience tested. Still, Windows 10 felt responsive and web browsing felt suitably slick without any noticeable slowdown.

MINER INCONVENIENCE

You can't expect anything more than the lightest gaming, though. The integrated Intel HD Graphics 515 managed a paltry 13.9fps in Dirt Showdown at 1,280x720 resolution, 4x anti-aliasing and High graphics, which is considered a fail in our benchmarks. If you want to play some Minecraft while you're on the move, the Yoga 700 should suffice, although its 128GB M.2 SSD doesn't leave much storage space once it's formatted and Windows 10 has been installed.

The Yoga 700's battery lasted 6h 54m in our test. Under light use, you should just be able to eke out a full day's use before you need to go in search of a power outlet.

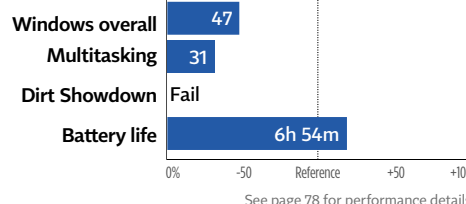
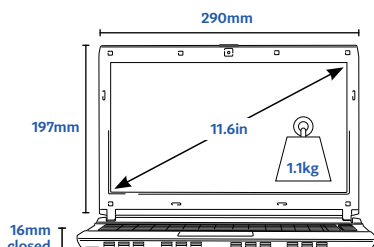
As a mid-range convertible, the Yoga 700 is underwhelming. It's delightfully portable, but its display doesn't do justice to its Full HD resolution and the keyboard leaves a lot to be desired. Acer's 11.6in Aspire Switch 11V has the edge in many areas but is itself let down by poor battery life. If you're not fussy about your keyboard or the quality of your display, the Yoga 700 is probably the strongest contender in a weak field, but those who want a more capable tablet-laptop hybrid should buy the Microsoft Surface 3 and a Type Cover.

Richard Easton



SPECIFICATIONS

PROCESSOR Dual-core 900MHz Intel Core M3-6Y30
RAM 8GB
DIMENSIONS 290x197x16mm
WEIGHT 1.1kg
SCREEN SIZE 11.6in
SCREEN RESOLUTION 1,920x1,080
GRAPHICS ADAPTOR Intel HD Graphics 515
TOTAL STORAGE 128GB SSD
OPERATING SYSTEM Windows 10 Home
WARRANTY One year RTB
DETAILS www.lenovo.com
PART CODE 80QE0005UK



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VERDICT

A super-cheap Chrome OS PC, but netbook-level performance limits its appeal

WE HAVE A LOVE-hate relationship with stick-based computers. Two previous efforts – Intel's Compute Stick and the Hannspree Micro PC – failed to win our hearts. They were too small, too clunky and, for most people, had little obvious use. The Asus Chromebit is another pocket-size PC stick, but this one runs Google's Chrome OS, thereby placing greater emphasis on web browsing and cloud-based computing.

The Chromebit is no more flexible than its Windows-based competitors for ports and connections, as it's hindered by the same physical limitations. It has just one full-size USB2 port and a power connector. Bluetooth 4.0 is also included, but you'll need a Bluetooth-compatible keyboard and mouse to take advantage of it. Alternatively, you can use a conventional wireless keyboard and mouse set that uses a single dongle, but that will take up your only USB port.

Adding a USB hub doesn't make things any easier, as the device starts to become unwieldy, defeating the object of its pocketable size. If you need more USB ports you should probably buy a mini PC such as the Dell Inspiron Micro instead.

The Chromebit is powered by an ARM-based Rockchip RK3288C processor. It's a quad-core chip that runs at up to 1.8GHz, and is paired with 2GB of 1,066MHz LPDDR3 RAM. It's not a powerhouse by any stretch of the imagination, but as is so often the case with Chrome OS, that doesn't necessarily hobble its performance too much. Google Docs runs smoothly and we never had any issues working on multiple documents and switching between windows.

Performance slowed when we were working on larger Google Docs spreadsheets, and copying and pasting between them took longer than we'd have liked. It never proved particularly frustrating as we were able to do everything we needed to do, but there's no denying that we felt a little hamstrung by its sluggish progress.

THE BIGGER PICTURE

Multimedia and ad-heavy web pages tended to lag and stutter when we scrolled down them, and loading times weren't exactly lightning fast. When you consider that the Chromebit costs just £94, though, it's all perfectly acceptable. We were particularly impressed with the performance of Polarr, a free photo editing program that's available on the Chrome Web Store. Manipulating images from a 20-megapixel camera was quick and easy thanks to the Chromebit's 600MHz ARM Mali-T760 GPU. We also tried to play a few web-based Flash games, although most of the titles we tried had huge



adverts present that made the games almost unplayable due to lag.

The GPU handled 1080p video without a hitch, making the Chromebit a viable media streamer if you want to plug it into the back of your TV. Just bear in mind that if you plug it into a device that has a resolution of more than 1,920x1,080, your desktop will be stretched because the HDMI connector on the Chromebit only supports Full HD resolution.

The Chromebit comes with just 16GB of onboard storage, and there's no microSD slot for expanding this. With Chrome OS installed, we had just under 10GB of free space. That's not much to work with, but since Chrome OS is designed to use the cloud for storage, downloading files to your device as and when you need them, this shouldn't be a problem.

OUT OF THE BLUE

This way of working may take some adjustment for those who are used to using a more traditional PC, where everything is stored locally. With internet speeds getting faster all the time and Google's web-based applications improving, however, working on files that never really reside on your local device is beginning to feel like the norm. You can also work on documents offline using the suite of offline Google Docs apps on the Chrome Web Store if you happen to take the Chromebit somewhere that doesn't have a stable internet connection.

On the face of it, the Asus Chromebit is good value. You'll need to buy a Bluetooth keyboard and mouse set or a USB hub to connect other wired peripherals, but £94 for a relatively capable PC is a bargain whichever way you look at it. It's a good buy if your demands are light and you already have a monitor with an HDMI port, and it's a fraction of the cost of a fully fledged Chromebook laptop. For everyone else, it's too limited to replace a genuine PC, both for power and flexibility. As a result, it's not much better than its Windows-based rivals. If you're looking for a proper tiny PC, we'd recommend saving up for the more practical MSI Cubi (see *Reviews, Shopper 331*) instead.

Michael Passingham

SPECIFICATIONS

PROCESSOR Quad-core 1.8GHz Rockchip RK3288C • **RAM** 2GB • **FRONT USB PORTS** 1x USB2 • **REAR USB PORTS** None • **TOTAL STORAGE** 16GB eMMC • **GRAPHICS** CARD Integrated ARM Mali-T764 • **DISPLAY** None • **OPERATING SYSTEM** Chrome OS • **WARRANTY** One year RTB • **DETAILS** www.asus.com/uk • **PART CODE** Chromebit CS10

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VERDICT

Big and brash, the Acer Predator 17 is a powerful and dependable gaming laptop with an excellent keyboard

IF YOU THOUGHT Alienware had the market for outlandish gaming laptops covered, think again. There's also the Asus RoG and HP Omen series, and now Acer has now joined the party with its gargantuan Predator 17.

This is a genuinely impressive-looking machine, primed with red highlights and a backlit red logo, and the palm rest is made from top-quality matt-black plastic. It's also one of the biggest laptops we've ever seen. Its 17.3in screen leaves a huge amount of room for the keyboard, macro keys and touchpad, and it weighs a little over 4kg, so Acer has completely thrown portability to the wind.

Even so, you can use the Predator 17 on your lap without discomfort, because despite the powerful components inside, it remains cool even when under load. This is partly due to its extremely loud rear fans, which by default are set to spin at maximum speed no matter what. Disabling this in Acer's PredatorSense software brings the noise down to a mere whisper.

FAN FRICTION

Thankfully, disabling the fans doesn't upset performance, as the Predator 17's quad-core Intel Core i7-6700HQ is an extremely competent multitasker. The chip runs at a base clock speed of 2.6GHz but can Turbo Boost to 3.5GHz when cool enough. Intel's Hyper-Threading also allows Windows to treat each of its four cores as two cores (one virtual, one physical) for improved performance in multithreaded programs.

The 16GB of DDR4 RAM is ample for the latest games and will aid performance with high-end multimedia work. In our benchmarks, it scored 108 overall, achieving 98 in image editing, 112 in video rendering and 109 in the multitasking tests. We'd expect this level of performance from a desktop Core i5 processor, so it's pretty impressive in a laptop.

The Predator 17 feels incredibly snappy in Windows, and we were never left waiting for it to load web pages and programs or to respond to searches. Its storage is quick, too, with a 256GB M.2 SSD backed up by a large 1TB hard disk.

For gaming, it's equipped with a 3GB Nvidia GeForce GTX 970M – Nvidia's second-best mobile graphics card. It's extremely capable at Full HD resolutions, ploughing through Dirt Showdown with an average frame rate of 80.8fps. In Metro: Last Light Redux with super sampling anti-aliasing switched on, it achieved an average of 31fps. The fans kicked up quite a fuss during these games but were never uncomfortably loud, and the palm rest didn't even become warm, let alone hot, which is quite a feat.

You can expect a little over three hours of usage time before the Predator 17's battery gives out. We found that it lasted 3h 37m in our test, although you might be able to eke out four hours if you're careful.

There's a generous selection of ports, too. Four USB3 connectors are present, along with HDMI and DisplayPort outputs for an external display, an SD card reader and a Thunderbolt port for high-performance storage and other high-end peripherals. There's also Gigabit Ethernet, 802.11ac Wi-Fi and Bluetooth, and two 3.5mm audio jacks for a microphone and headphone setup.

The keyboard deserves special credit, as it's by far the best laptop keyboard we've ever used. Its large, chunky keys have plenty of travel and give excellent feedback. It's fully backlit, too, making typing easy in the dark.

The macro keys are in a slightly awkward place – off to the side, away from the conventional keys – and are shallower than the standard letter keys. With five macro groups, however, you have a total of 25 customisable shortcuts, which you can set in the PredatorSense software to change settings such as fan speed and GPU usage, as well as more advanced user-defined macros.

The touchpad is also excellent. It's responsive and its buttons are pleasing to the touch. There's even a button that disables the touchpad and the Windows key to avoid unnecessary interruptions while gaming.

PANEL BEATER

Another point in the Predator 17's favour is its superb Full HD IPS panel, which has lovely wide viewing angles. It displays 91% of the sRGB colour gamut, ranking it among the best non-professional laptops we've tested, and its low 0.25cd/m² black levels are a good deal better than the competition's. Bright, 320cd/m² white levels are also very good.

The Acer Predator 17 manages to justify its eye-watering price with top-level performance, and its superb build quality make it genuinely desirable. It's in competitive company, though. The £1,380 Gigabyte P37W v4 is a lot thinner and lighter, making it far more practical for mobile gamers, but if you don't mind the extra bulk and you value an excellent display, the Acer Predator 17 is a great choice.

Michael Passingham



SPECIFICATIONS

PROCESSOR Quad-core 2.6GHz Intel Core i7-6700HQ

RAM 16GB DDR4

DIMENSIONS 423x322x40mm

WEIGHT 4kg

SCREEN SIZE 17.3in

SCREEN RESOLUTION 1,920x1,080

GRAPHICS ADAPTOR Nvidia GeForce GTX 970M

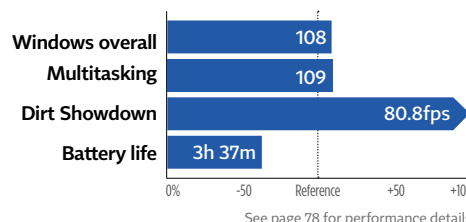
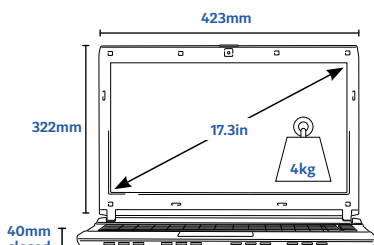
TOTAL STORAGE 256GB M.2 SSD, 1TB hard disk

OPERATING SYSTEM Windows 10

WARRANTY One year RTB

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VERDICT

A gorgeous phone with a superb screen and camera, but it just isn't fast enough to compete with other flagships

THE HTC ONE M9 was one of the biggest smartphone disappointments of 2015, but HTC's latest smartphone, the One A9, is everything the M9 should have been and more. A big part of its appeal lies in its stunning design. Its clean lines and metal chassis may be eerily reminiscent of Apple's iPhone 6 and 6s but it's a winning combination. It's not only easier to hold than Apple's iPhone but also very light for its size, weighing just 143g.

The One A9 is immediately more appealing than the M9, not least because of its 5in, 1,920x1,080 AMOLED display. Covering 100% of the sRGB colour gamut and producing perfect 0.00cd/m² blacks, it's far superior to the M9's display, and its contrast ratio of infinity:1 ensures there's plenty of detail in darker images. Whites are a little yellow, but we didn't find it particularly bothersome. The screen's peak brightness is also low at 347.19cd/m², but that's not unusual for an AMOLED display.

The One A9 comes with Android 6.0 Marshmallow installed, but with HTC's Sense 7 UI on top it won't look the same as Google's Nexus devices. This isn't a problem, as Sense 7 is very customisable. For example, its Theme Generator lets you change the appearance of individual app icons, fonts and the caller ID logo either using one of the handful of themes on offer or one you've made yourself using images from your gallery.

Once you've chosen an image, the Theme Generator analyses the colours present in the picture and suggests different combinations for your home screen, Blinkfeed hub and settings menu, which you can then tweak to your liking. It's a brilliant touch, and even photos containing only a few colours gave us plenty of options.

HAND SIGNAL

A fingerprint sensor offers added security. Located at the bottom of the handset, it's fast and rarely made mistakes when we used it to unlock the phone. Alternatively, the grooved power button is at thumb height and easy to find. On the other side of the phone is a microSD card slot, which you can use to expand the default 16GB of storage, just 10GB of which is available to the user.

The One A9 is powered by an octa-core 1.5GHz Qualcomm Snapdragon 617 processor and 2GB of RAM. It's a shame it doesn't use a Snapdragon 810 like the One M9, but it's still quick. In our benchmark suite, it showed a significant increase in speed over older Snapdragon 615 handsets, as its Geekbench 3

scores of 732 in the single-core test and 3,050 in the multicore test were on average around 100 and 800 points faster respectively.

For a phone that costs £420 SIM-free or £28.50 per month on contract, however, this is rather sluggish. The Samsung Galaxy S6 costs just £350 SIM-free or £27.50 per month on contract, for example, and is vastly superior to the One A9 – apps open faster and the operating system feels more responsive.

SHADOW PLAY

Gaming performance is also lacklustre for a £420 handset. The One A9 managed just 411 frames in the offscreen Manhattan test in GFX Bench GL, which is roughly 6.6fps. That's by no means a bad score, but complex 3D games such as Hearthstone aren't as smooth as they could be. The same goes for web browsing, as its Peacekeeper score of 793 is a long way behind the Galaxy S6's 1,257. Web pages were quite jerky at times, particularly if they contained lots of images or embedded videos.

Battery life just about scrapes into double figures, as its 2,150mAh battery lasted 10h 2m in our test. This should get you through the day, but it's a long way behind other flagship phones such as the LG G4 and the Galaxy S6.

The One A9's rear camera has received several improvements. Despite a 13-megapixel sensor (down from the One M9's 20-megapixel snapper), its overall picture quality is much better. Photos are a fraction darker in places, but switching on HDR quickly sorts this out. Indoor photos looked great, too. The only major disappointment is the flash, as it made images look green.

As a whole, the HTC One A9 looks and feels like a first-class handset. Sense 7 is a great interface and it has a beautiful design. The sticking point is the price. At £420 SIM-free or £28.50 per month on contract, it's up against the competitive Samsung Galaxy S6, which is faster, cheaper and has a better battery life. The One A9 isn't great value, but that doesn't make us like it any less. It's definitely a better buy than the One M9, but it doesn't do quite enough to make the big leagues.

Katharine Byrne



SPECIFICATIONS

PROCESSOR Octa-core 1.5GHz Qualcomm Snapdragon 617 • SCREEN SIZE 5in • SCREEN RESOLUTION 1,920x1,080 • REAR CAMERA 13 megapixels • STORAGE 16GB • WIRELESS DATA 4G • DIMENSIONS 146x71x7.3mm • WEIGHT 143g • OPERATING SYSTEM Android 6.0 • WARRANTY One year RTB • DETAILS www.htc.com • PART CODE One A9

Battery life

10h 2m

0% -50 Reference +50 +100

See page 78 for performance details

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VERDICT

The OnePlus 2 is yet another fantastic flagship killer that's great value

WHEN IT FIRST launched last year, the OnePlus 2 was available only to people who had a special invitation. Now OnePlus has lifted this restriction to make its second flagship smartphone available to all, which is great news for anyone who wants a top of the range smartphone for less than £300.

On paper, it shares several specifications with its equally excellent predecessor, the OnePlus One, including a 5½in, 1,920x1,080-resolution display, a rear 13-megapixel camera and either 16GB or 64GB of storage. However, the OnePlus 2 comes with Qualcomm's new octa-core 1.8GHz Snapdragon 810 chipset, giving it the same processing power as other 2015 flagships, such as the Sony Xperia Z5. The 16GB version's 3GB of RAM is already a step up from the old handset, but the 64GB version has 4GB, giving it the capacity for heavy multitasking without a stutter.

We tested the latter specification, and it's surprising what an extra 1GB of RAM can do. In Geekbench 3's multicore test, the OnePlus 2 scored a massive 4,744, putting it around

The OnePlus 2 is a superb gaming device, too, managing 1,396 frames (roughly 23fps) in the offscreen GFX Bench GL Manhattan test. This puts it miles ahead of any smartphone in its price range – the £250 Motorola Moto X Play produced just 361 frames or 5.8fps.

The only area that lets the OnePlus 2 down is its web browsing performance – its Peacekeeper score of 827 is barely 100 points in front of the 3rd Gen Moto G. This showed in daily use, too, as scrolling up and down news articles with embedded videos was occasionally quite jerky. Still, it's perfectly fast enough given the price, even if it's somewhat below average for this particular chipset.

You needn't worry about the OnePlus 2's battery life, as its 3,330mAh battery lasted a respectable 11h 13m in our test. While not as impressive as the 13 hours produced by the Galaxy S6 and Moto X Play, it beats the HTC One M9, so its stamina levels are competitive.

Handsets with 5½in screens aren't for everyone, but the OnePlus 2 is relatively compact. Measuring 152x75x9.9mm, its

A large part of the OnePlus 2's appeal rests on its choice of OxygenOS rather than standard Android

700 points ahead of other flagship phones that have the same processor but only 3GB of RAM, including the Xperia Z5.

In fact, the OnePlus 2 is bettered only by the Samsung Galaxy S6 Edge and S6 Edge Plus, as the ordinary Galaxy S6 scored just 4,501. The S6 closed the gap in Geekbench 3's single-core test, beating the OnePlus 2's score of 1,210 with 1,427, but that's still highly impressive when you consider that the OnePlus 2 is almost half the price. Needless to say, the OnePlus 2's OxygenOS, which is based on Android 5.1, ran beautifully, with no signs of slowdown even when we jumped in and out of apps quickly.

curved back fits well in the hand and its metal frame is easy to grip. We're not big fans of the default sandpaper texture on the rear panel, but you can switch it for one of OnePlus's £20 removable wooden covers if you prefer.

Sadly, the display quality left something to be desired, as our colour calibrator returned an sRGB colour gamut score of just 89.6%. That's a little below average, even for a mid-range handset. Reds and magentas were by far its weakest coverage area. It picks up a lot of fingerprints, too, so you'll have to clean it regularly.

Its high brightness level of 599.41cd/m² can detract from the screen's vividness, but whites are very clean as a result. The screen's black levels are also surprisingly low at 0.29cd/m² and its high contrast ratio of 2,039:1 provides plenty of detail, illuminating areas of dark shadow much more effectively than the Moto X Play, for example.

The rear camera has one of the better 13-megapixel sensors we've seen.

Colours were rich and vibrant in outdoor shots and plenty of detail was present across the frame. There aren't many



modes available, but HDR helped brighten any dark shadows. Its performance indoors was even more impressive, as colours had plenty of punch, even in low light, and noise was kept to a minimum.

A large part of the OnePlus 2's appeal rests on its choice of OxygenOS rather than standard Android. It looks very similar to vanilla Android but adds several handy features, such as customisable navigation buttons, a battery-saving dark colour scheme and individual app permissions, so you can decide which bits of data your apps can access while still having full use of the app in question. A fingerprint scanner is built into the home button, and there's a USB Type-C port for charging, so you can finally bid farewell to fiddly Micro USB ports.

With so much going for it at such a great price, there's no denying that the OnePlus 2 is a fantastic handset and great value. Its battery life and display may not be as good as the £250 Moto X Play's, but its excellent camera and super-fast processor put the OnePlus 2 in a class of its own. It wins a Best Buy award.

Katharine Byrne

SPECIFICATIONS

PROCESSOR Octa-core 1.8GHz Qualcomm Snapdragon 810 • **SCREEN SIZE** 5½in • **SCREEN RESOLUTION** 1,920x1,080 • **REAR CAMERA** 13 megapixels • **STORAGE** 64GB • **WIRELESS DATA** 4G • **DIMENSIONS** 152x75x9.9mm • **WEIGHT** 175g • **OPERATING SYSTEM** OxygenOS (Android 5.1) • **WARRANTY** One year RTB • **DETAILS** www.oneplus.net/uk • **PART CODE** OnePlus 2



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VERDICT

The Smart Speed 6 isn't without its flaws, but there's simply nothing better for £50

MOTOROLA MIGHT BE the biggest name in budget smartphones, but Vodafone's own-brand Smart handsets have been fighting back hard. First Vodafone released the £125 Smart Ultra 6 to combat the £160 3rd Gen Moto G, with better specs and a larger, Full HD screen. Now it's taking aim at the £90 2nd Gen Moto E with its £50 Smart Speed 6, providing a long-overdue shot in the arm for ultra-cheap prepaid phones.

Measuring 132x65x9.9mm, the Smart Speed 6 is ideal for those who want a small, compact handset. It's narrower and easier to hold than the Moto E, and it feels well made and sturdy in the hand, even if its plain silver chassis won't exactly turn heads. The 4½in display is a magnet for fingerprints too, but that's something to be expected at this end of the price spectrum.

The 4½in screen is relatively decent. While the lowly 854x480 resolution makes

level of 0.32cd/m² and its contrast ratio of 1,035:1 are right up there with more expensive budget smartphones. The Moto E still has the edge with its richer, brighter colours, but the Smart Speed 6 certainly raises the bar for other £50 handsets.

It puts up a decent fight against the Moto E for performance, too. The Smart Speed 6's quad-core MediaTek MT6735M chip runs at a slower clock speed of 1GHz compared with the Moto E's 1.2GHz Snapdragon 410 chip, but it wasn't far behind in our benchmark results. In Geekbench 3, the Smart Speed 6 managed 457 in the single-core test and 1,292 in the multicore test – just 100 points behind the Moto E's multicore test score.

In day-to-day use, the Smart Speed 6 ran its stock version of Android 5.1 very smoothly, with apps loading just as quickly as on the Moto E. Simple 2D games ran perfectly well on the Smart Speed 6 too, and we were able

In day-to-day use, the Smart Speed 6 ran its stock version of Android 5.1 very smoothly, with apps loading quickly. Simple 2D games ran perfectly well, too

desktop-based web pages tricky to navigate, the screen's sRGB colour accuracy score of 70.9% isn't nearly as low as those of some sub-£100 phones we've tested. Admittedly, that still isn't great, as the screen's strong yellows and blues and weak reds and greens can often make images look rather cool and dingy. Likewise, with a peak brightness of just 335.25cd/m², we found the screen quite difficult to see clearly in bright sunshine.

For a £50 phone it's really not that bad, however, and the screen's viewing angles are surprisingly wide compared with those of other handsets at this price. We were able to see the screen clearly from various oblique angles, and its black

to play games such as Threes! and Alphabear without any trouble. It will struggle with more complex games such as Hearthstone, though. Its score of just 342 frames (or 5.5fps) in the onscreen Manhattan test in GFX Bench and 84 frames (or 1.4fps) in the offscreen test show it isn't cut out for demanding 3D titles.

Web browsing shouldn't pose too much of a problem, as the Smart Speed 6 coped well with most of the websites we visited. The *Guardian* site could be a little halting at times, particularly while pages were loading, but otherwise scrolling was reasonably smooth and hassle-free.

Its battery life is excellent too. Despite having only a 1,780mAh battery, the phone lasted an impressive 10h 24m in our continuous video playback test with the screen brightness set to 170cd/m².

The Smart Speed 6 isn't without its problems, though. Its 8GB of storage leaves users with just 4.6GB of available storage, for example, so anyone who wants to download lots of apps will probably need to invest in a microSD card. The slot for this is found under the rear panel.



The rear 5-megapixel camera isn't much to shout about either, as the lack of touch focus controls can leave photos looking very blurry and smeary. As a result, all our test photos lacked detail, and the outlines of objects looked soft and fuzzy. We weren't surprised that indoor photos looked even worse, as even shots taken in bright light produced a lot of noise and grainy artefacts.

Camera and storage issues aside, the Vodafone Smart Speed 6 is a highly accomplished smartphone for just £50, and its decent performance and battery life make it a compelling option next to the £90 2nd Gen Moto E. The Moto E's superior screen and marginally better camera are worth the extra £40, but if you absolutely don't want to spend more than £50 on your smartphone and you don't mind joining Vodafone PAYG in the process, the Smart Speed 6 is by far the best smartphone in its price range. It wins a Recommended award.

Katharine Byrne

SPECIFICATIONS

PROCESSOR Quad-core 1GHz MediaTek MT6735M • **SCREEN SIZE** 4½in • **SCREEN RESOLUTION** 854x480 • **REAR CAMERA** 5 megapixels • **STORAGE** 8GB • **WIRELESS DATA** 4G • **DIMENSIONS** 132x65x9.9mm • **WEIGHT** 146g • **OPERATING SYSTEM** Android 5.1 • **WARRANTY** One year RTB • **DETAILS** www.vodafone.co.uk • **PART CODE** Vodafone VF-795

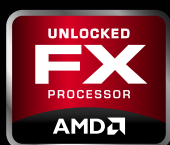


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VERDICT

A glimpse into the future of mobile working, but you need a sluggish Lumia 950 to use it

LAST MONTH, WE tried out Windows 10 Mobile and all its brand-new features (see *Shopper 337*). Now we've had a chance to test Microsoft's official Display Dock, the optional £80 adaptor you'll need if you want to use Windows 10 Mobile's biggest and most exciting feature, Continuum, which in effect turns your smartphone into a portable PC.

At the moment, Continuum only works on the Lumia 950 and 950 XL phones (see *Reviews, Shopper 337*), as you need a USB Type-C port to connect the Display Dock. It's likely that future Lumia handsets will come with Continuum support, but the Display Dock isn't compatible with older phones.

The idea is simple. By connecting your phone to the Display Dock, you can use the Dock's HDMI or DisplayPort output to connect an external monitor, allowing you to run a full PC-like desktop using the hardware in your smartphone. You can use fullscreen apps such as Outlook, Office, Edge and Maps without the need for a PC or laptop, and you can even use your phone while it's connected, so you won't have to stop what you're doing to answer a call or reply to a text.

NERVE CENTRE

As well as two display outputs, the Display Dock has three USB2 ports for a wired mouse and keyboard. Bluetooth is also available if you want to cut down on wires. It's a shame that none of the ports is USB3, but one of them doubles as a charging port, so you could power another device such as a tablet or battery pack while you work. Even better, the USB Type-C connection charges your phone while it's connected.

The Display Dock is surprisingly heavy for its size, weighing 230g despite its small footprint of 64x64x26mm. As a result, you

won't need to worry about it sliding round your desk with every mouse movement, as its rubbery, soft touch underbelly stays firmly in place. Alternatively, you can use your smartphone's display as a makeshift touchpad if you need to free up a USB port, although we'd recommend using a mouse where possible as the lack of tactile feedback on the screen meant we weren't always sure we'd tapped it correctly.

This is exacerbated by the phone's hardware, as we found that even the Lumia 950 XL's octa-core 2.0GHz Qualcomm Snapdragon 810 chip and 3GB of RAM weren't quite powerful enough to run Windows 10 on a big screen without any lag.

Navigating the desktop was absolutely fine, but trying to switch between multiple tabs in Edge often took a second, contributing to our uncertainty as to whether our taps had registered when using our phone as a touchpad. Scrolling down pages could also be rather jerky at times, particularly when they included video, and web browsing in general was sluggish compared with a laptop or PC.

Another limitation is that Continuum only works with Microsoft's universal apps, so you may have several apps on your phone that you can't use through the Display Dock. That means no Netflix, Skype, Spotify, Twitter or Xbox apps, to name just a few – at least until their developers make them truly universal.

Thankfully, key apps such as Word, Excel, OneNote, Outlook and OneDrive are supported, and it's these that make Continuum shine. We had no performance issues while typing out Word documents or working on Excel spreadsheets, and in many respects it was just like working on a laptop.



You can also use the File Explorer app to open Full HD videos, pictures, documents and music files from your phone's internal storage, or any files you have on a USB stick. 1080p video works a treat, as we were able to play the Full HD version of our usual open-source test movie (*Tears of Steel*) without any stutter or lag.

REVOLUTIONARY ROAD

Web browsing issues aside, Microsoft's Display Dock could potentially revolutionise mobile office working. When you can run all your basic office apps from your phone, the need to carry a laptop around all day becomes practically nonexistent. Of course, a fair amount of infrastructure would need to be in place before we reached a stage when we could simply plug in our phones and get down to work, but provided your workplace has the correct monitor, cables and accessories, Continuum has huge possibilities.

The only real problem with the Display Dock is that it essentially forces you to use either the Lumia 950 or Lumia 950 XL as your main handset. As we discussed in our review last month, the Lumia 950's operation isn't as smooth as we'd expect from a £420 phone, and even the £470 Lumia 950 XL isn't as slick as its Snapdragon 810-based Android rivals.

The XL is still a good phone, and we found its display, camera and battery life equal to, if not better than, those of the regular Lumia 950. But when it's dogged by so many daily irritations, we hesitate to recommend it – and by extension the Display Dock – over other flagship smartphones. Continuum is certainly a big point in its favour, but you'll need to be prepared for a rather rocky transition if you're making the jump from Android or iOS.

Katharine Byrne



SPECIFICATIONS

VIDEO OUTPUTS HDMI, DisplayPort • **USB PORTS** USB Type-C x2, USB x3 • **DIMENSIONS** 64x64x26mm • **WEIGHT** 230g • **WARRANTY** One year RTB • **DETAILS** www.microsoft.com • **PART CODE** HD-500

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GOOGLE Pixel C



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VERDICT

The Pixel C has plenty of power and a brilliant keyboard dock, but Android isn't the best OS for getting work done

GOOGLE HAS TASKED other companies with manufacturing its Nexus tablets in the past, but that changes with the Pixel C. It's the first Google tablet designed and built entirely in house and takes its name from the company's premium range of Chromebook Pixel laptops.

With a metal frame, unusual 1:V2 aspect ratio (roughly the same as an A4 piece of paper) and no logos, it's a seriously good-looking tablet. At 7mm thick and weighing 520g, it's not the slimmest or lightest device around, but the squared edges leave plenty of room for the beautifully machined speaker grilles on either side. The slim row of rear LEDs is another great touch – a double-tap shows the tablet's remaining battery life.

It's an attractive tablet, but it's only when you pair it with the optional £119 Bluetooth keyboard that the Pixel C really stands out. A simple magnetic docking hinge locks the Pixel C securely in place and can be adjusted to any angle up to 90°. It's firm enough that you won't knock it back when tapping the touchscreen, and it docks onto the back of the tablet when not in use. Inductive charging means you won't need to charge it separately.

A few keys are slimmer than usual, but otherwise it's comfortable to type on and the keys have a surprising amount of travel. Sadly there's no backlight, but it's a small complaint.

Thanks to its stunning 10.2in, 2,560x1,800-resolution display, the Pixel C is great to use both as a tablet and a laptop. The aspect ratio gives you more room when using it in portrait mode, and its pixel density of 308ppi makes images and text look sharp.

Colour accuracy is also exceptionally high. According to our calibrator, the Pixel

C displays 97.3% of the sRGB colour gamut. That's second only to Samsung's AMOLED Galaxy Tab S2 and Apple's iPads, and it shows when watching video or looking at photos. The brilliant 450.6cd/m² maximum brightness and 1,550:1 contrast ratio are also notable, as is the low 0.28cd/m² black point.

It's a shame, then, that the touchscreen on our review unit felt rather buggy, failing to respond to quick swipes and taps at times. It didn't happen all the time, but it was frustrating when it wouldn't let you swipe away a YouTube video or quickly navigate through Google Photos.

As good as the tablet looks, Android just isn't particularly well suited for use in landscape orientation. Apps such as Instagram and Vine force the tablet into portrait mode, even when docked with the keyboard, and others such as Twitter don't fill the screen when viewed in landscape. Despite Google's original plan to introduce a multi-window mode with Android 6.0 Marshmallow, it was deemed unstable and won't be available any time soon. That means you're stuck with running one app at a time, which is a long way behind Microsoft's Surface Pro 4 and even the iPad Pro's Split View.

TOASTING MARSHMALLOW

If you don't mind the lack of multitasking, however, Marshmallow runs beautifully on the Pixel C. Google has moved the onscreen Back and Home buttons to the bottom left edge of the screen and the Recents button to the bottom right, making them easier to reach.

The Pixel C is the first tablet to use Nvidia's 1.9GHz octa-core Tegra X1 chip, and it flew through our benchmarks. With scores of 1,347 and 3,976 in the Geekbench 3 single-core and multicore tests, it's one of the fastest 10in tablets around, only falling behind Sony's Xperia Z4 Tablet and Apple's iPad range. A score of 1,572 in the Peacekeeper browser benchmark was more average, but the Pixel C could still browse through media-heavy web pages without any sign of stutter.



Graphics performance is where the Pixel C really shines, though, as its 1,744 frames in GFX Bench GL's onscreen Manhattan test is faster than almost every Android tablet we've tested, and an offscreen score of 3,318 is even quicker than Apple's gigantic iPad Pro.

POWER HOUR

Despite this, the Pixel C has impeccable battery life, lasting 14h 33m in our looping video test with the screen brightness set to 170cd/m² – a good five hours more than the iPad Pro. When you do eventually run out of juice, charging it with the bundled USB Type-C power adaptor takes around five hours.

There's no microSD card slot, so you'll have to choose between either 32GB or 64GB of built-in storage at the point of purchase.

The Pixel C is a powerful, long-lasting and beautifully built tablet with a keyboard dock to match. For occasional typing, single-task working and multimedia playback, it's an excellent device, but it's questionable whether Android is ready for laptop use. The lack of multitasking definitely hurts it in comparison with Apple's latest iPads and, at £399, it's rather expensive. It's only a little more than Sony's Xperia Z4 Tablet when you add the cost of the keyboard, and if you're looking for something cheaper but still very capable, you can buy the Nexus 9 for just £180.

Tom Morgan

SPECIFICATIONS

PROCESSOR Octa-core 1.9GHz Tegra X1 • **SCREEN SIZE** 10.2in • **SCREEN RESOLUTION** 2,560x1,800 • **REAR CAMERA** 8-megapixel • **STORAGE** 32GB • **WIRELESS DATA** No • **DIMENSIONS** 242x179x7mm • **WEIGHT** 520g • **OPERATING SYSTEM** Android 6.0.1 • **WARRANTY** One year RTB • **DETAILS** store.google.com/product/pixel_c • **PART CODE** Pixel C 32GB



COMPACT CAMERA

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VERDICT

Some performance issues, but the Canon G5 X has outstanding image quality and ergonomics for such a small camera

THERE USED TO be a gulf in image quality between compact cameras and SLRs, but now it's less clear cut. The Canon G5 X has a 1in sensor – sitting roughly between the $\frac{1}{2}$ in sensors in cheap compacts and the APS-C sensors in consumer SLRs – and it's mounted behind a wide-aperture lens, starting at f/1.8 for wide-angle shots and f/2.8 for telephoto. That's four times brighter than the f/3.5-5.6 kit lenses supplied with most SLRs and CSCs.

A key factor for image quality is the total light that reaches the sensor, which is determined by both the aperture and the sensor size. The G5 X is equivalent to f/4.9-7.6 on a full-frame camera, which is marginally better than almost every SLR and CSC costing less than £1,000 – with their kit lenses, at least. Not bad for a camera that weighs 377g and is significantly smaller than any SLR or CSC with a zoom lens attached.

This impressive feat of miniaturisation comes with surprisingly few compromises. The most significant is the 210-shot battery life, which may not last a day's shooting. Spare batteries are expensive at £50 each. One saving grace is that you can charge them either in-camera or with the supplied charger.

Build quality, controls and ergonomics are harder to fault. The magnesium body and metal dials feel reassuringly solid, and the rubber handgrip is more substantial than we're used to seeing on this type of camera. It doesn't protrude further than the lens (when switched off) so won't add to the dimensions.

VIEWING PLATFORM

The LCD screen folds out to the side and can tilt or rotate for easy framing. The electronic viewfinder is pin sharp with its 1,024x768 resolution and turns on automatically as the camera is raised to the eye. The image could be bigger, though. The viewfinder hump is home to a hotshoe – a feature absent from Sony's RX100 series. Putting a flashgun on such a small camera might seem strange, but it's ideal for wireless flash units.

The command dial sits under the forefinger, and the exposure compensation dial falls under the thumb. There's a mode dial on the other side, as well as a lens ring and rear wheel. The lens ring, command dial and

rear wheel can be assigned various functions, with different duties depending on the exposure mode.

There isn't much room on the back for buttons, but key functions such as drive mode, autofocus area and exposure lock are covered. Most other photographic controls are accessed via the Q menu, but this is quick to navigate via the touchscreen.

The touchscreen is particularly welcome for moving the autofocus point, especially during video capture. Video mode includes onscreen buttons for exposure lock, exposure compensation and manual focus. Full manual exposure controls are also available and can be adjusted via the touchscreen to avoid shaking the camera or spoiling the soundtrack by using the physical controls.

Video quality was generally excellent, with responsive autofocus, pleasing colours, sharp focus and little noise in low light. Fine details looked a little coarse compared with 1080p videos from the Panasonic RX100 IV and LX100, and the G5 X lacks those cameras' 4K video capture and slow motion features, but 1080p is likely to be enough for most people.

Built-in Wi-Fi provides remote control and wireless transfers when used with an Android or iOS device. Holding our phone and camera together during image playback established a connection between the two and invited us to select photos to transfer at 4-megapixel resolution. The remote viewfinder function includes access to exposure settings, and there's an option to keep a log of the GPS location in the app and use this to geotag photos based on capture time.

The G5 X isn't exactly fast. On first inspection, it took 0.9 seconds between each shot, but we found that the camera wasn't refocusing or checking the metering between shots when we

pressed the shutter button again immediately after capturing a picture. To invoke autofocus and metering, we had to wait a little longer before taking the next shot, slowing capture down to a disappointing 1.9 seconds.

Continuous mode started at 6.7fps, slowing to 5.9fps after 15 frames, but this too fixed the focus and metering. Selecting Servo mode for continuous autofocus gave a respectable 4.2fps but the camera struggled to track moving subjects and metering was still fixed. Switching to Raw mode saw performance plummet to 1.2fps.

SEE THE LIGHT

Fortunately, image quality was excellent throughout. Details were crisp, colours were lifelike and automatic exposures were well judged. The wide-aperture lens helped to keep the ISO speed down in limited light, and noise levels remained remarkably low at ISO speeds up to 1600. With an aperture equivalent to f/4.9-7.6 on a full-frame camera, this little camera not only performs well in low light, but also gives a narrow depth of field to help subjects stand out from their backgrounds.

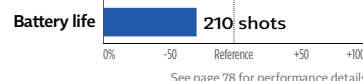
With exceptional image quality from such a small camera, anything less than five stars may seem harsh. The G5 X's performance should be better, though, and it won't fit comfortably into a trouser pocket. It also has the formidable Panasonic LX100 to contend with. The LX100 is bulkier but has a bigger sensor for even better image quality in low light, 4K video and much faster performance. The LX100 remains our favourite premium compact camera, but the G5 X isn't far behind.

Ben Pitt



SPECIFICATIONS

SENSOR RESOLUTION 20 megapixels • **SENSOR SIZE** 1in • **VIEWFINDER** Electronic (2,360,000 dots) • **LCD SCREEN** 3in (1,040,000 dots) • **OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS)** 4.2x (24-100mm) • **35mm-EQUIVALENT APERTURE** f/4.9-7.6 • **WEIGHT** 377g • **DIMENSIONS** 76x112x52mm • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **PART CODE** 0510C012AA



PREMIUM COMPACT CAMERA

SONY Cyber-Shot RX100 IV



£759 inc VAT • From www.johnlewis.com

VERDICT

Packed with premium features and with a price tag to match, the Sony RX100 IV is a formidable compact camera

THE SONY RX100 IV is a camera for people who shudder at the thought of compromise. With a 1in sensor and f/1.8-2.8 lens, it has the same light-gathering ability as a full-frame camera with a f/4.9-7.6 lens. This is marginally better than most SLRs and CSCs with their kit lenses, so we can expect image quality to be in the same league. It's far smaller than any SLR or CSC, though, weighing 298g and measuring just 41mm thick. It slips easily into all but the tightest of trouser pockets.

While its closest competitors, the Canon G7 X and G5 X (see p39) make you choose between an electronic viewfinder and a truly pocket-size design, the RX100 IV incorporates a high-quality viewfinder that retracts into the camera when not needed. There's also an LCD screen, which tilts down by 45° and up by 180° for self-portraits. Continuous shooting is phenomenally fast at 16fps, or 5.5fps with continuous autofocus. Video enthusiasts will also love the 4K video capture, the built-in neutral-density filter for wide apertures in bright light and the ability to shoot 1080p video at up to 1,000fps for 40x slow motion.

TALENT SHOW

In fact, the RX100 IV has so many talents that it's easier to list the things it can't do. The screen isn't touch-sensitive, and there aren't many single-function buttons for quick access to settings. Exposure compensation, drive mode and flash settings have dedicated buttons, and the latter two, plus a Custom button, can be assigned to various other settings. A rear wheel and lens ring provide quick access to manual exposure settings, but photographers who like to take control will spend a fair amount of time navigating the menus. There's no hotshoe for external flashguns and wireless triggers either. Battery life is on the short side at 280 shots, but better than the rival Canons' 210 shots.

The 2.9x zoom, with its 24-70mm equivalent focal length range, is relatively modest. It's smaller than the Canon G7 X and G5 X's 25-100mm range but not much different to an SLR or CSC's kit lens, which typically has a 27-82mm equivalent focal length range. That brings us to its chief limitation: you can't swap the lens. This is disappointing for a £759 camera, as the RX100 IV's lens can't compete with wide aperture, telephoto and other specialist lenses in similarly priced competitors. The RX100 IV isn't as easy to use as other £750 cameras either. The smooth metal front leaves little to hold onto, and its small buttons make basic adjustments tricky.

The RX100 IV makes up for this in speed, capturing a photo every 0.4 seconds in normal use. Autofocus speed was impressive, taking around 0.3 seconds even in very low light. We noticed more autofocus errors than normal, though, averaging about 5% across our tests. Continuous mode came in at 15.5fps and lasted for 47 JPEGs before slowing to 5.1fps, which is phenomenal. Raw capture was slower at 8.5fps, dropping to 1.6fps after 27 frames, but that's still faster than most cameras at this price manage for JPEGs.

FINE ART

This fast performance also benefits video capture. The 4K video mode produces 8-megapixel frames and picture quality is fantastic. Details were much sharper than from any 1080p footage, not just when viewed on a 4K display but also when resized to 1080p resolution. The camera switches to a flatter colour profile for video, which gives a better starting point for colour grading in editing software. Autofocus was smooth and reasonably responsive, although without a touchscreen it's not really feasible to move the autofocus point around while recording.

The RX100 IV's slow motion mode is the best implementation we've used. 1080p video is captured at 250fps, 500fps or 1,000fps for 10x, 20x or 40x slow motion. It's not quite as good as it sounds, though. Videos are encoded at 1080p but the sensor readout

drops as the frame rate goes up. The 20x and 40x modes aren't really up to scratch but 10x slow motion looks superb.

Autofocus and exposure must be primed before recording can start, and capture is limited to two seconds, after which the video plays back in slow motion as it's written to the memory card. This makes the process pretty labour-intensive, but that's not necessarily a bad thing. It's still worryingly easy to fill your hard disk up with slow motion videos.

The RX100 IV's image quality is extremely impressive, too. The 1in, 20-megapixel sensor captures enough detail for A3 prints. Details looked clean, sharp and natural in bright light, except for the occasional autofocus error. When a fast shutter speed or diminishing light placed higher demands on the camera, the bright f/1.8-2.8 lens helped to keep noise low.

Our only real criticism is that the RX 100 IV isn't as good in low light as the Canon G5 X. The differences are minor, though, and we wouldn't choose one over the other purely on this basis. Both cameras use 1in sensors and f/1.8-2.8 lenses, and there's little to separate them for image quality.

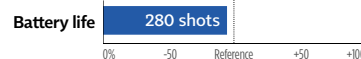
There's no denying that the RX100 IV is a hugely impressive camera. It's not perfect, but there's nothing here we'd classify as a deal-breaker. Its only real problem is some formidable competition. We prefer the Canon G5 X's controls and image quality, but if you want the viewfinder, 4K video, 1080p slow motion and blistering performance, all squeezed into your pocket, the Sony RX100 IV is uniquely placed to deliver it.

Ben Pitt



SPECIFICATIONS


SENSOR RESOLUTION 20 megapixels • **SENSOR SIZE** 1in (13.2x8.8mm) • **VIEWFINDER** Electronic (2,359,296 dots) • **LCD SCREEN** 3in (1,228,800 dots) • **OPTICAL ZOOM** (35mm-EQUIVALENT FOCAL LENGTHS) 2.9x (24-70mm) • **35mm-EQUIVALENT APERTURE** f/4.9-7.6 • **WEIGHT** 298g • **DIMENSIONS** 59x104x41mm • **WARRANTY** One year RTB • **DETAILS** www.sony.co.uk • **PART CODE** DSC-RX100M4




See page 78 for performance details



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CURVED ULTRA-WIDE MONITOR

PHILIPS

Brilliance BDM3490UC



£670 inc VAT • From www.laptopsdirect.co.uk

VERDICT

The Philips BDM3490UC is expensive, but this curved monitor has excellent image quality

CURVED TVs HAVE been around for over a year now, but the Philips Brilliance BDM3490UC is the first curved monitor we've tested. It's a 34in display with a 21:9 aspect ratio, a 3,440x1,440 resolution and a very gentle curvature radius of 3,800mm. That's about as shallow as curved screens get – the smaller the radius, the tighter the curve – so the overall effect is actually very subtle. You'll need a fair amount of room to use the BDM3490UC, though, as its 53cm footprint is one of the biggest we've seen.

The middle of the monitor's curved stand houses its other headline feature, a pair of integrated front-facing 7W stereo speakers, which are hidden behind a grey metal grill. They're perfectly decent, although you might expect more given their prominence and the price of the monitor. They're loud and clear for the most part, and you can adjust the sound using the DTS Audio settings in the onscreen menus, but we were unable to find a setting to improve their basic performance.

SWEET WRAPPER

Curved screens divide opinion. We happen to think they work well on very large TVs because they surround the viewer, creating a more immersive experience. We're less convinced of their worth on smaller TVs, and doubly so for monitors. With an ultra-wide display, however, the curve has the effect of drawing your eyes into the screen and making the edges easier to see. It's not a life-changing effect, but it's still appreciated.

At the back, the monitor has four USB3 ports (one of which supports fast charging for your phone and can power larger devices such as portable hard disks), a DisplayPort connector and three HDMI ports. One of these supports the newer HDMI 2.0 standard

so can output 4K video at 60fps, but the others are only HDMI 1.4, with one providing MHL support for your smartphone (again, allowing you to charge it). There are also two 3.5mm audio jacks, one input and one output.

The 3,440x1,440 resolution is welcome, too. Split the screen down the middle and you get two pleasingly sized 1,720x1,440 windows, which are nearly as wide as a Full HD screen and significantly taller. With this kind of space to work in, it's a far neater alternative to a pair of Full HD monitors.

There's also just about enough room to place three windows side by side, but sadly the monitor doesn't come with any software that lets you go beyond Window 10's effective but simplistic window management. You'll have to use third-party software such as DisplayFusion to get the most out of the available space if you want to organise your windows more creatively.

Image quality is this display's strongest suit. In our colour coverage tests, it displayed an impressive 98.7% of the sRGB gamut and achieved a fantastic delta E score of just 1.49. Delta E measures colour accuracy – the lower the score, the less difference there is between the ideal colour and the colour that the monitor is able to display, so a score of 1.49 puts it among very good company.

The BDM3490UC struggled with only a couple of colours. Reds were ever so slightly too dark and greens were a little oversaturated, but photos and videos still looked bright and vibrant. Out of the box, the monitor is set to produce 309.6cd/m² white

levels, which is too high for long periods of use, but switching to the Office preset lowered the brightness to a more comfortable level.

If you have your brightness settings on high, however, bear in mind that it will affect the monitor's black levels, as we measured a reading of 0.34cd/m² out of the box. This improved slightly to 0.31cd/m² when we switched to the Office preset, but it's still not as low as we'd usually expect given the price.

WIDE ANGLE

Viewing angles are helped by the screen's concave design but its extreme width gives rise to a strange effect where the bottom corners of the screen appear to be darker than the rest. Fortunately, this is only visible when sitting close to the monitor, and disappears completely at around 75cm away, so as long as you place the monitor at the back of your desk it should be fine. Its input lag reading of 10.5ms is incredibly low for an IPS display too, so it's a good screen for gaming, both for PC and console players.

The Philips Brilliance BDM3490UC is a very expensive monitor, and curved designs aren't to everyone's taste, but its image quality is excellent and its large, high-resolution screen is great for multitasking. However, we're not sure the curve makes enough of a difference to justify its premium price, especially when you can buy the far more practical AOC 3477PQU for £120 less, which still has an ultra-wide 34in 3,440x1,440-resolution screen but opts for a flat, height-adjustable panel instead of a curvy, fixed-height one.

Michael Passingham



The dedicated speaker looks good, but it doesn't offer stunning sound



SPECIFICATIONS

SCREEN SIZE 34in • RESOLUTION 3,440x1,440 • SCREEN TECHNOLOGY IPS • REFRESH RATE 60Hz • VIDEO INPUTS DisplayPort, 3x HDMI (1x HDMI 2.0) • WARRANTY Three years RTB • DETAILS www.philips.co.uk

CONNECTION PORTS

DisplayPort



HDMI x3





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CURVED UHD TV

SAMSUNG UE48JU7500

COMPUTER SHOPPER ★★★★★
RECOMMENDED

£879 inc VAT •

From www.cramptonandmoore.co.uk

VERDICT

A stylish UHD TV with decent image quality and great smart TV features

SAMSUNG'S JU7500 SERIES sits at the top of its standard range of Ultra HD TV sets, just missing out on its flagship 'SUHD' badge. The 48in UE48JU7500 on test here is the smallest in the range, but it's also available with a 55in, 65in or 78in screen. Each TV comes with the same hardware and software, so we'd expect image quality to be similar across the range.

The design of Samsung's TVs has become fairly predictable in recent years, but that's not to say the UE48JU7500 doesn't look great. With its inward-facing, metallic-style bezels, the TV's chamfered border looks thinner than it really is and draws your eyes into the screen. The stylish stand also matches the display's 3,000mm curvature radius, although this may prove troublesome if you have a standard, flat sound bar that usually sits in front of your TV. A sound base or curved soundbar might be a better option.

The JU7500 offers plenty of inputs, most of which are found on Samsung's bundled OneConnect Mini box, which you can place out of the way with just a single cable connecting it to the back of the TV. This contains four HDMI 2.0 inputs (all of which are ARC compatible), two USB2 ports and an



The only real omission is a hybrid EPG system such as Freetime or Freeview Play. This is becoming a mainstay of rival TVs such as Panasonic's Firefox-powered sets, as it lets viewers scroll back through the last seven days of content rather than having to locate a particular programme through the relevant app. It's not a huge problem when the JU7500 comes with apps for the major UK TV catch-up channels, but it means the TV is slightly less flexible than the competition.

Fortunately, the JU7500 more than makes up for this with superb image quality. With its Ultra HD 3,840x2,160 resolution and white level of 281cd/m², this TV serves up truly dazzling images. What's more, Samsung's UHD Dimming technique, which breaks the

The curve has its share of problems too. If you sit directly in front of the TV, viewing angles are great, but as soon as you venture off to the sides, as guests and members of your family are likely to do, image fidelity starts to decrease toward the edge of the screen. The TV's speakers are decent, but you'll want to switch to the clearer Movie mode instead of putting up with the flat, dull-sounding Standard profile.

Full HD upscaling works very well for the most part, however, and even standard-definition broadcast TV looks good. The JU7500 is also a great TV for gamers. In Game Mode, we measured input lag of just 20.8ms, making it one of the most responsive panels we've tested. With Game Mode switched off, input lag jumps to a huge 108ms, making this mode essential for would-be gamers.

The Samsung JU7500 series of TVs is an excellent step up to Ultra HD content. Its image quality is superb, and few other TVs can beat its wide array of smart TV features. For roughly the same price, you can get the larger, flat 55in Panasonic Viera TX-55CX700B, which has just as many apps plus Freeview Play, but anyone who wants an excellent curved TV need look no further.

Michael Passingham

With its Ultra HD 3,840x2,160 resolution and white level of 281cd/m², this TV serves up truly dazzling images

optical S/PDIF connector, but you'll also find an RJ45 network adaptor, a USB3 port, a 3.5mm headphone jack, satellite and aerial connectors, as well as component and composite inputs on the TV itself.

The JU7500 uses Samsung's own Tizen operating system, which is one of the best we've seen. It's easy to use, and the gesture controls on Samsung's excellent Smart TV remote are well-suited to navigating its large menus. There's also a more conventional remote control in the box.

Likewise, the JU7500's selection of apps and catch-up TV services is second to none. Every major service is catered for here, including BBC iPlayer, ITV Hub, All 4, Demand 5, Netflix, YouTube, Amazon Instant Video and Wuaki.tv, giving it one of the most comprehensive line-ups of catch-up TV services you'll find today.

screen down into small sections with individual contrast and brightness controls, allows for seriously deep, inky blacks.

In Standard image mode, we measured a black level of 0.07cd/m² on a black patch surrounded by white, which is incredibly impressive considering this isn't an OLED display. The lack of HDR support is a shame, but at least dark portions of the screen will look faithful to the original against bright, crisp focal points. We also measured a basic sRGB colour coverage of 92% in Standard mode, which is very easy to tweak given the JU7500's wealth of colour options.

The JU7500 isn't perfect, though. We noticed some judder on small, fast-moving objects, particularly flying space debris in our test scenes from *Interstellar*. Sadly, Samsung's Auto Motion Plus frame interpolation options did little to help the situation.

SPECIFICATIONS

SCREEN SIZE 48in • **NATIVE RESOLUTION** 3,840x2,160 •
VIDEO INPUTS 4x HDMI 2.0, Composite, Component •
TUNER Freeview HD, Freesat HD • **DIMENSIONS**
1,081x681x308mm • **WARRANTY** One year RTB •
DETAILS www.samsung.com/uk • **PART CODE** UE48JU7500

CONNECTION PORTS





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PHILIPS

MULTIROOM SOUNDBAR

RAUMFELD Soundbar



£930 inc VAT • From uk.raumfeld.com

VERDICT

With its superior music playback, Raumfeld's Soundbar feels more like a large multiroom speaker than a dedicated TV soundbar

RAUMFELD'S SOUNDBAR IS designed to fit into the company's multiroom system in a similar way to Sonos's Playbar, providing both a TV audio upgrade and a way of playing streamed audio. At £930, it's one of the more expensive soundbars on the market, but with a wireless active subwoofer it compares well with its subwoofer-less Sonos rival.

Another advantage the Soundbar has over the Sonos Playbar is an HDMI ARC output. This allows you to control it using your TV remote, cutting down on the number of cables coming out of your TV. The Soundbar also has optical and RCA phono connections, but it lacks Bluetooth support, so you can't use it to play music from your phone or tablet.

The Soundbar is available in either white or a black metal finish, with a speaker cloth that covers the full length of its rather sizable chassis. Measuring 990x110x113mm when



The active subwoofer is a large rectangular speaker with a similar metallic finish to the main soundbar. It's wireless and designed either to lie flat or stand vertically on one end, so you could place it against a wall. At 955x330x120mm, however, you might be hard pressed to fit it in a cabinet or under a sofa.

The only controls on the Soundbar itself are the volume and power buttons. Two status LEDs indicate that the Soundbar has power and is connected to your network, but there's nothing to show which source the Soundbar is currently receiving audio from.

You have to use the included metal remote control to switch between the auxiliary, HDMI ARC and optical connections. As with other Raumfeld products, the remote also

stage than most soundbars, delivering clear dialogue with a proper centre channel. You can also choose from Arena, Theatre and Voice sound modes, which change the profile of the sound. Arena and Theatre modes create an even wider, more immersive soundstage using the side-firing speakers, while Voice emphasises the centre channel for dialogue.

The Soundbar performs best when playing music, however. With its six 70mm full-range drivers, it delivered an incredibly crisp, encompassing sound that was distributed equally around the room. The subwoofer's three additional high-excursion drivers also produced some of the deepest bass we've heard. In fact, we could still feel it from across the room even after toning it down as far as it would go, so it might not be the best choice for those with easily disturbed neighbours. Sadly, there's no night mode to dampen the sound.

The Raumfeld Soundbar is without doubt a great speaker and subwoofer combination, but its superior music playback makes it feel more like one of Raumfeld's multiroom speakers than a dedicated TV soundbar. It's also very large and expensive. Admittedly, the Sonos Playbar costs more when you add the cost of the Sonos sub, but it gives you the option of adding rear speakers to create a 3.1 or 5.1 audio system. Raumfeld's Soundbar on the other hand can only be used as an additional multiroom speaker.

As a result, it's hard to recommend the Soundbar as a good starting point for improving your TV's audio unless you already have an existing Raumfeld multiroom system in place. At this price, the Sonos Playbar and LG's MusicFlow HS9 provide a better foundation and give you more options for expansion later.

Richard Easton

The Soundbar delivered an incredibly crisp, encompassing sound that was distributed equally around the room

attached to its pre-assembled base, the Soundbar is very tall compared with its competitors and can easily obscure your TV's IR receiver when placed in front of it.

This is less of a problem for wall-mounted TVs, but if you have your TV on a stand, you'll need to make sure there's enough clearance to accommodate the Soundbar, particularly as Raumfeld doesn't include an IR Blaster to alleviate the problem. It comes with brackets for wall-mounting the Soundbar, but bear in mind that it weighs a substantial 8.6kg.

has four preset buttons that let you access any profiles you've saved in the Raumfeld app, such as albums or playlists. The remote control isn't paired with the Soundbar when you first use it, however, so you'll have to go through the tedious process of pairing the two manually, which we finally managed to do after several failed attempts.

To set up the Soundbar, you'll need to download the Raumfeld Controller app, which is available for iOS and Android devices. You can also use the app to connect the Soundbar to your home network, which thankfully is much simpler than trying to pair the Soundbar with the remote.

The app allows you to group and control other Raumfeld speakers in concert with the Soundbar, so you can play music from services such as Spotify (through Spotify Connect), Tidal and TuneIn Radio, as well as from networked computers and storage, in different rooms simultaneously. There are even basic EQ controls for bass and treble, although if you want to adjust the subwoofer, you have to use its rear physical controls.

When we tested the Soundbar by watching a film, it offered good stereo separation and the subwoofer's incredible bass really made sound effects come alive. It has a wider sound



SPECIFICATIONS

SPEAKERS 6 + 3 • **RMS POWER OUTPUT** 150W + undisclosed
DIMENSIONS 990x110x100mm + 955x330x120mm •
DOCK CONNECTOR None • **NETWORKING** 802.11n •
WEIGHT 8.6kg • **WARRANTY** One year RTB • **DETAILS**
uk.raumfeld.com • **PART CODE** Raumfeld Soundbar

MODULAR BLUETOOTH SPEAKER

COWIN Ark



£99 inc VAT • From www.johnsmith.co.uk

VERDICT

The Cowin Ark is a novel concept, but its design and execution fall short of its potential

THE ARK IS a little different from other Bluetooth speakers. Rather than a single portable unit, it has two components: the Cruze, which is a rather standard-looking Bluetooth speaker, and a wireless base station that contains the Ark's subwoofer.

The two units attach magnetically and use the same inductive charging technology you'll find on smartphones that support Qi wireless charging. As such, when you're not using the base station to charge the Cruze, you can charge a compatible smartphone simply by placing it on top of the base station – a handy feature that frees up a plug socket. Alternatively, you can charge the detachable Cruze unit using a Micro USB cable.

At 200x60x65mm, the Cruze is compact enough to carry around with you. It comes with a travel bag, and Cowin gives it a battery life rating of eight hours, making it a good portable companion for outdoor activities and



move. It measures a substantial 300x170x145mm, so it's hardly something you'll want to carry from room to room very often, and with no built-in battery you need to keep it plugged in via its DC jack.

Touch-sensitive media playback buttons on the top of the Cruze allow you to control your music. You can use either Bluetooth, NFC or the 3.5mm auxiliary jack to play tracks from

the Cruze to make hands-free conference calls thanks to its built-in microphone, and it's sensitive enough to pick up your voice comfortably from around 2m away.

Inside its case, the Cruze has two speaker drivers with a passive radiator. It doesn't fare particularly well on its own, producing a thin sound that doesn't make much of an impact. Music becomes much livelier when it's paired with the base station's 3½in subwoofer, creating a more forceful sound.

While the bass isn't wanting for brute force, however, it lacks refinement. The Ark struggled to play *Tidhar* by The Toure-Raichel Collective, which has a particularly unruly bass part. The cabinet vibrated with each beat, which was distracting. Even less challenging tracks sounded muddy at times, but the Ark copes reasonably well for the most part. It's respectably loud too, producing enough sound to fill a medium to large room, although it begins to distort at higher levels.

The idea behind the Cowin Ark is a good one. Portable speakers can often lack bass, so a modular Bluetooth speaker is a clever solution. However, the execution leaves a lot to be desired, and its design is likely to divide opinion. The base station should only really be augmenting the bass delivery from the Cruze, but instead the Cruze's almost nonexistent bass leaves it sounding tinny and flat without its companion. Given a choice, we'd still rather buy a separate Bluetooth speaker with better sound quality and no subwoofer, such as the Cambridge Audio G2 (see *Shopper* 325).

Richard Easton

Portable speakers can often lack bass, so a modular Bluetooth speaker is a clever solution

use around the home. Its sharp edges don't feel particularly refined but at least it comes with a cleaning cloth to help you keep its brushed-metal finish looking pristine.

The subwoofer has a similar brushed-metal finish but is surrounded by white plastic edges, with four white feet protruding from the base. We weren't particularly fond of its design, as it looks more like a toaster than a piece of audio equipment. With the Cruze placed on top, the whole assembly looks a bit like a robot thanks to the two visible drive units inside.

Perhaps not surprisingly, the subwoofer is intended for use at home rather than on the

your phone or tablet. Audio prompts talk you through the pairing process but these sounded rather comical and a little jarring (we'll never hear the word 'connecting' the same way again). The Cruze doesn't remember the volume setting after being put into standby either, so we had to turn the volume back up whenever we switched it on.

Fortunately, the two parts of the Ark don't need to be in constant contact during music playback, as they pair themselves wirelessly. This gives you some freedom to move the Cruze around, although the units can only maintain a connection over a distance of around 10m. You can also use



SPECIFICATIONS

SPEAKERS 2 + 1 • **RMS POWER OUTPUT** 10W + 25W •
DOCK CONNECTOR None • **WIRELESS** Bluetooth (SBC) •
DIMENSIONS 200x60x65mm (Cruze), 300x170x145mm
 (Subwoofer) **WEIGHT** 450g (Cruze), 1.9kg (Subwoofer) •
WARRANTY One year RTB • **DETAILS** www.cowinmusic.com • **PART CODE** COWINARK41

HIGH-RES MEDIA PLAYER

PIONEER XDP-100R



£499 inc VAT • From www.petertyson.co.uk

VERDICT

Superb sound quality and room for expansion, but the XDP-100R is undeniably expensive

SOUND QUALITY HAS been on a downward spiral ever since CDs gave way to MP3s. Smartphones are now the *de facto* device for listening to music on the move, but few can play high-resolution 24-bit/192kHz FLAC and DSD128 files. Thankfully, Pioneer's XDP-100R is here to fill in the gap.

This high-end Android-powered portable media player splits its circuitry in two to ensure that nothing interferes with audio playback. One PCB contains the CPU, sensors, wireless chips and display controller, while the other is dedicated to the ESS SABRE DAC and amplifier. In Stand-alone mode, it cuts out all electromagnetic signals except audio for uninterrupted, interference-free music.

This level of attention to detail even extends to the materials used to build the device. Made from aluminium, it has a removable bumper on the top edge to help protect the 3.5mm jack from undue stress that could damage your headphones. It's chunkier than your typical smartphone but easy enough to grip in one hand, and the power, play and skip track buttons are all placed within easy reach of your fingers.

As well as 32GB of onboard storage, it has two microSD card slots for a potential maximum capacity of 256GB. This is essential for large, high-resolution audio files and gives the XDP-100R a huge advantage over media players that rely entirely on internal storage.

The oversized volume dial is a nice touch, replicating a hi-fi volume control. Initially, placing the XDP-100R in a pocket could accidentally change the volume, but a quick trip into the settings menu allowed us to lock the volume whenever the screen is switched off.

The screen isn't quite up to the standard of the rest of the unit, but we're inclined to forgive the 4.7in, 1,280x720-resolution display's mediocre image quality when its primary function is to display album art. It's surprisingly bright at 417cd/m², and its contrast ratio of 966:1 isn't bad either, but its peak black levels of 0.43cd/m² and meagre 86.7% sRGB colour gamut coverage pale beside a typical £500 smartphone.

The Qualcomm 2.2GHz Snapdragon 800 processor isn't exactly cutting edge either,

but Geekbench 3 single-core and multicore scores of 885 and 2,794 are respectable, as is a Peacekeeper browser benchmark score of 827. All this translates to very snappy performance in Android 5.0.1 Lollipop.

You can play games, too, as its GFXBench GL Manhattan scores of 1,578 (or 25fps) and 697 (or 11fps) in the onscreen and off-screen tests show. Admittedly, it took a while to open Blizzard's *Hearthstone*, but battle animations were smooth once it had loaded.

Battery life is good, too. In everyday use, we got 10 hours of 24-bit/96kHz audio playback, and around 16 hours with MP3s. The micro USB charging port also acts as a

USB OTG digital output, so you can use the XDP-100R with an external digital amplifier.

Clearly, Pioneer has created a competent media player, but that would mean nothing if its sound quality wasn't up to scratch. Thankfully, tracks have a delightfully neutral presentation no matter what you feed it. The XDP-100R avoids sounding harsh without dulling more vibrant, energetic tracks, while acoustic tracks and quieter songs sound lifelike. Numerous EQ presets are available through Pioneer's Music app, but they have a rather minor effect on the mix and are best left off.

We could easily hear the subtler notes and instrument noises of Fleetwood Mac's *Rumours* when playing 24-bit FLAC files, but the XDP-100R does a good job of cleaning up MP3s too. Even better, a forthcoming firmware update will bring support for MQA compression, which folds the higher frequencies that are often lost when encoding audio as an MP3 into the available frequency range. Compatible players can then 'expand' the file to get the full quality, while players that don't support the standard can still play the basic version.



This high-end portable media player splits its circuitry in two to ensure that nothing interferes with audio playback

The player also supports wireless playback. There's no NFC for easy pairing, but aptX Bluetooth ensures audio quality doesn't take a hit, while 802.11ac Wi-Fi ensures you'll get the fastest possible downloads on a compatible wireless network.

The XDP-100R sounds fantastic with the right headphones and a high-resolution FLAC or DSD file, and the upscaling system does wonders with MP3s too. It's the most up-to-date Android-powered media player around, with Google Play for downloading apps and the hardware to play most games smoothly. It's also cheaper than its biggest rival, the £800+ Sony ZX2 Walkman, which has a lower-resolution screen, slower hardware and an older version of Android.

Dedicated media players aren't for everyone. Unless you have a library of FLAC and DSD files, a serious pair of headphones and a desire to listen on the move, your smartphone will usually suffice for MP3s. If you demand quality, though, and don't mind paying for it, the Pioneer XDP-100R is a great alternative to smartphone listening.

Tom Morgan

SPECIFICATIONS

SPEAKERS 1 • **RMS POWER OUTPUT** N/A • **DOCK CONNECTOR** None • **NETWORKING** Wi-Fi, Bluetooth (aptX) • **DIMENSIONS** 127x76x12mm • **WEIGHT** 181g • **STREAMING FORMATS** Bluetooth, Spotify Connect • **WARRANTY** One year RTB • **DETAILS** www.pioneer.eu • **PART CODE** XDP-100R

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4K CAMCORDER

PANASONIC HC-VX980

COMPUTER
SHOPPER



RECOMMENDED

£649 inc VAT • From www.jessops.com

VERDICT

Not a big departure from older models, but the HC-VX980 is a great update to Panasonic's 4K camcorder range

CAMCORDERS ARE A shrinking market.

Most people are now happy shooting video on their smartphones, while action cameras now allow you to shoot video where you couldn't shoot before. However, that hasn't stopped a few mainstays from continuing to release new camcorders, and Panasonic is one such company that's staying the course.

Camcorders have a distinct advantage over smartphones when it comes to capturing video, as their ergonomics not only make for a far more comfortable shooting experience, they also put an end to the blight of vertically shot video footage. Panasonic's HC-VX980 is no exception in this case, as its 350g chassis is nicely balanced and won't wear your arm out.

You can pair up to three smartphones with the HC-VX980 using its built-in Wi-Fi support

It's lost the twin camera function of its predecessor, the HC-WX970, which let you flip out the LCD screen to shoot a secondary picture-in-picture view to capture your own reactions against the footage you're shooting, but we always felt this was a bit of a gimmick.

There's also no need for a twin camera when you can pair up to three smartphones with the HC-VX980 using its built-in Wi-Fi support to achieve the same effect. Once your phones are paired with the camcorder via the Imaging app, you can switch between them to record up to two additional pieces of footage using its two PIP overlays, providing another angle on whatever you're shooting.

It works well enough, but the secondary footage can be a bit jarring at times, as the quality of footage is obviously dependent on the quality of your smartphone's camera.

Shooting more traditional video from the HC-VX980's $\frac{1}{2.3}$ in BSI MOS, 18.9-megapixel sensor still provides wonderful results. This is the same sensor as the HC-WX970 and, as before, allows recording at up to 4K resolutions with the ability to grab 8-megapixel stills from your resulting footage.

These stills are of a high enough resolution for prints or publishing on social media, and we found picture quality was pretty good provided we had plenty of adequate lighting. There was a high level of detail and sharpness across the frame, and colours are nice and vibrant. Likewise, its auto-focus performance

is great, with the camcorder smoothly changing the focus points between subjects.

The quality of our video footage also fared well in bright light, thanks to its $f/1.2$ - 3.6 aperture lens. It can also record 1080p at up to 50Mbit/s and 4K at 72Mbit/s, but the HC-VX980 struggled with noise in poor light.

The HC-VX980's main attraction is the new cropping function. This benefits hugely from the additional resolution offered by 4K and, once processed, the resulting footage can be turned into 1080p video at 25fps. There are also post-panning, post-tracking, post-zooming and post-stabilising options.

Post panning lets you set a final panning destination on the camcorder, and it will then automatically zoom in and crop to 1080p as it pans across. You'll achieve the best results with the camcorder placed on a tripod, but we found it worked very well during testing.

Post tracking, on the other hand, lets you select a moving target, which it will then track as you pan. This can be rather robotic in motion, as the target stayed in largely the same part of the frame at all times, and it didn't look as natural as tracking a subject manually by hand. It was also rather temperamental, often failing to match the subject's movement altogether.

Post zooming, meanwhile, lets you get a closer view, albeit at the cost of resolution, but you can set the zoom speed to provide a degree of cinematic control. Finally, the post stabiliser helps steady your footage by strategically cropping in to help reduce camera shake. Of the four, we found this most useful for trickier shooting situations, but the camera's five-axis hybrid optical image stabilisation also performed well without it.

The HC-VX980's High Dynamic Range support is limited to 1080p shooting, but it does provide a more balanced exposure in high-contrast scenes without looking overly artificial. There's also a dedicated slow motion mode that lets you slow footage down up to three times per recording for dramatic effect.

The only downside to the HC-VX980 is the fact that you have to use its grainy, fold-out LCD display to change settings. The onscreen menu isn't particularly intuitive, and finding the 4K cropping modes can be fiddly. You'll eventually get to know where everything is, but it can take some getting used to when you first turn the camcorder on.

Battery life is top-notch. Shooting 1080p at 28Mbit/s, the camcorder managed 1h 55m, dropping to 1h 38m at 50Mbit/s.

Aside from the second camera, the HC-VX980 hasn't changed much from the previous model, but that doesn't make it any less of a worthy update. Some of the new 4K cropping functions are a bit hit and miss, but the addition of more complex slow-motion effects and the ability to link up multiple smartphones makes the HC-VX980 an excellent 4K camcorder for every occasion.

Richard Easton



SPECIFICATIONS

OPTICAL ZOOM 20x • SENSOR $\frac{1}{2.3}$ in BSI MOS •
LCD SCREEN 3in, 460,800 dots • DIMENSIONS
73x65x139mm • WEIGHT 351g • WARRANTY One year
RTB • DETAILS www.panasonic.com •
PART CODE HC-VX980

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CANON i-Sensys MF724Cdw

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£328 inc VAT • From www.printerland.co.uk

VERDICT

Canon's i-Sensys MF724Cdw is a competent colour laser MFP

CANON'S I-SENSYS MF724CDW is a colour laser multifunction peripheral (MFP) for the home or small office. It costs more than an entry-level device, but the extra outlay buys a better specification: the MF724Cdw has a 50-page automatic document feeder (ADF) and can print and scan automatically on both sides of a page, so you can sit back while it makes a double-sided copy of a double-sided document. You can connect it to a wired or wireless network, and it has a front-panel USB port for direct scans and prints.

Even for its type this is quite a heavy MFP; you'll need two people to unpack it. We weren't keen on its large touchscreen, which seemed slow to respond and not always accurate. We tried to update the firmware, but over several attempts the MFP reported either that the server wasn't available or that there had been a communication error.

It may have a good range of features, but the MF724Cdw isn't especially fast: Canon quotes a modest 20 pages-per-minute (ppm) print speed, and we recorded 16.5ppm in our

letter test. We were more impressed by its colour graphics speed of 14.8ppm, though. The flipside of this relaxed pace is that the print engine is unusually quiet, with the hush spoiled only by a loud cooling fan.

Connected over wired Ethernet, the scanner needed 25 seconds to capture an A4 page at 300 dots per inch (dpi), but only 15 seconds at 150dpi. Single-page photocopies were quite quick for a laser device, taking just 15 seconds in black or 18 seconds in colour. Using the ADF, we made 10 single-sided mono copies in 43 seconds – quick enough – while the same job in colour was less competitive, needing 77 seconds.



Test results were impressive.

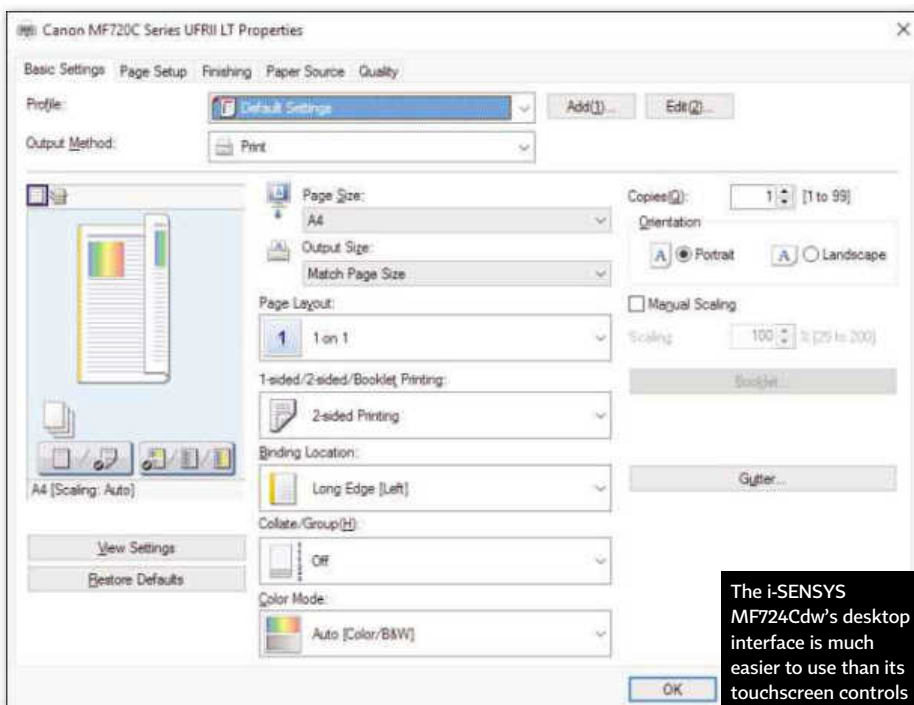
Black text prints were predictably good, but colour graphics were great, with strong colours, a consistent toner finish and no artefacts or jaggedness. Unfortunately, the printer's tendency toward lively colours was less welcome on photos, which seemed warm and a little too saturated. The MF724Cdw's scanner is better than most office devices. Despite a maximum resolution of 600dpi, scans were sharply focused and packed full of detail, with the Auto Tone feature ensuring great exposure on a range of originals.

Unlike Dell's competing H825cdw (see *Shopper* 337), the MF724Cdw has just four consumables which each combine toner and drum. Fairly typically, those supplied in the box are good for a meagre 1,200 black and 1,400 pages, but normal capacity replacements should print around 3,400 black pages and 2,900 in colour, giving running costs of around 94p per page. Buy the black value pack, which contains two toners giving 6,800 pages, and this falls to 8.9p.

A comparable inkjet would still be cheaper to run, but if you're set on a laser device there's little between this and Dell's H825cdw. Both are good: buy the latter if speed is a priority, or the MF724Cdw for lower costs.

Simon Handby

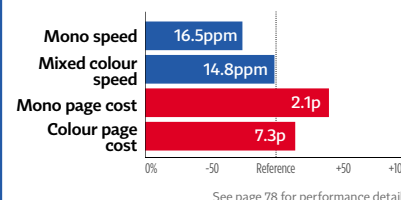
Test results were impressive. Black text prints were predictably good, but colour graphics were great



The i-SENSYS MF724Cdw's desktop interface is much easier to use than its touchscreen controls

SPECIFICATIONS

TECHNOLOGY Single-pass colour laser • **MAXIMUM PRINT RESOLUTION** 600x600dpi • **MAXIMUM OPTICAL SCAN RESOLUTION (OUTPUT BIT DEPTH)** 600x600dpi (24-bit) • **DIMENSIONS** 479x430x484mm • **WEIGHT** 31kg • **MAXIMUM PAPER SIZE** A4/legal • **WARRANTY** Three years RTB (promotion ends 29/2/16) • **DETAILS** www.canon.co.uk • **PART CODE** 9947B044



CANON Pixma MG5750

COMPUTER SHOPPER

★★★★★

BEST BUY

£70 inc VAT • From www.amazon.co.uk

VERDICT

The right balance of features, performance and quality makes the Pixma MG5750 a winner

CANON'S PIXMA MG5750 is the latest in a long line of inkjet multifunction peripherals (MFPs) designed for the home. It's a squat, smart-looking device, made from high-quality black plastics. It can print, scan and copy, print automatically on both sides of a sheet of paper (duplex printing), and you can share it on a wireless network. There's no fax modem, however. As you might expect, there's support for printing from or scanning to cloud services including Google Drive, but signing the printer up is far more involved than it is for products from rival manufacturers such as HP.

As a mid-range device, this Pixma gets Canon's unusual five-ink print engine, which combines dye-based black, cyan, magenta and yellow inks with a bigger, pigment black tank for better text printing. While that's a good thing, we're disappointed that the MG5750 is lumbered with a clunky control system. Rather than a touchscreen input, its menus are navigated with a four-way rocker switch paired with three dedicated buttons below the screen; we've long criticised this setup, which can be inconsistent and confusing.

The MG5750 inherits another feature we've criticised before. Its ink cartridges are

reached by raising up the cantilevered control panel, but the access is a bit restricted at the rear of each slot. What's more, although the slots are clearly marked, it is physically possible to insert the dye-based cartridges in the wrong slot; we're not sure why there's no keying to prevent this. The printer's paper trays have an unusual layout where printed pages spill onto a stop that pivots out of the input tray; it looks basic, but the neat design does keep everything tidy.

Fortunately, these minor grumbles couldn't spoil another great mid-range home MFP. While it isn't exactly fast, it delivered

standard-quality text at 11.5 pages per minute (ppm), and produced our complex colour graphics test at 3.6ppm, which is fine at this price. The scanner was quick enough at low resolutions, with a 300 dots per inch (dpi) A4 scan needing just 19 seconds, but even using a USB connection, we needed 103 seconds to capture a postcard-sized photo at 1,200dpi. A black photocopy of an A4 page took just 13 seconds, but in colour this rose to 30 seconds.

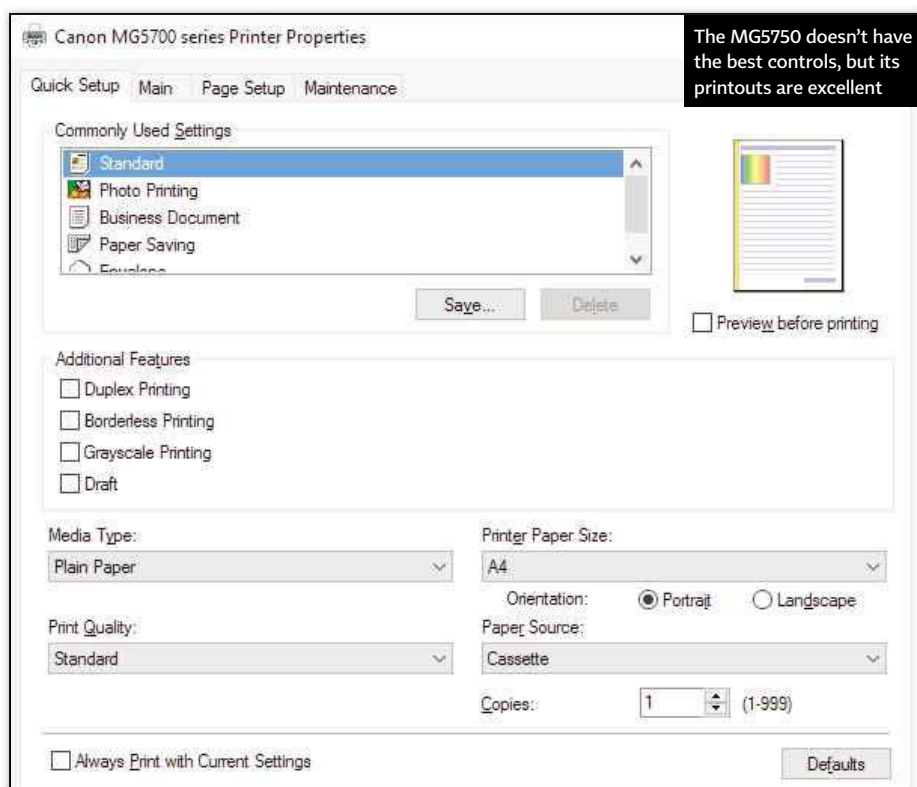
This MFP's best feature is the all-round high quality of its results. Text and graphics printed on plain paper were bold and crisp, while its photo prints were as good as you'll get from a mid-range inkjet: free of grain, and impressively sharp. Photocopies were faithful to the original, while scans were also sharp, with accurate colours and a high dynamic range.

Stick to Canon's XL ink cartridges and this MFP will print each A4 page of mixed text and graphics for about 6.3p, which is competitive. While we've a couple of minor reservations about its design, the MG5750 is affordable to buy and run, has decent speeds and delivers great-quality results. It's a great all-rounder for the home, and wins our Best Buy award.

Simon Handby

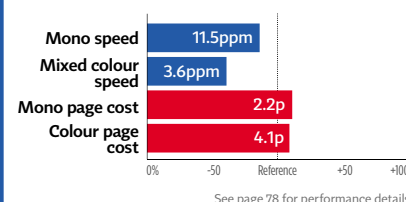


Text and graphics were bold and crisp, while photo prints were as good as you'll get from a mid-range inkjet



SPECIFICATIONS

TECHNOLOGY Thermal inkjet • **MAXIMUM PRINT RESOLUTION** 4,800x1,200dpi • **MAXIMUM OPTICAL SCAN RESOLUTION (OUTPUT BIT DEPTH)** 1,200x2,400dpi (24-bit) • **DIMENSIONS** 148x455x369mm • **WEIGHT** 6.3kg • **MAXIMUM PAPER SIZE** A4/legal • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **PART CODE** 0557C006



DEVOLO Home Control Starter Pack



£200 inc VAT • From www.broadbandbuyer.co.uk

VERDICT

Not quite as smart as it should be, but this home automation kit has real promise

DEVOLO IS BEST known for its range of Powerline HomePlug networking products, so it was a surprise to see the German company launch a range of smart home kit. The Home Control Starter Pack contains a control hub, a door sensor and a plug adaptor for controlling devices such as lamps. Optional components include a smoke detector, motion sensors, thermostats, wall switches and key fobs. Surprisingly, given that most lights are fitted into ceilings rather than free-standing lamps, Devolo doesn't sell compatible lightbulbs.

The control hub connects to your router via Ethernet or Powerline; there's no Wi-Fi option. It communicates with all the other components using Z-Wave, so basic functions will still work in the event of an internet outage. It should be compatible with non-Devolo Z-Wave smart home products, but we didn't have the chance to test this.

The control hub is set up using a web browser on a computer, and you have to create an online Devolo account. Everything is then configured and controlled remotely from the web interface, which is easy to use despite the occasional bit of untranslated German. You can also use the iOS, Android or Amazon Fire My Devolo apps, but these aren't quite as well organised as the web interface.

The setup wizards include videos showing how to set up each component, although these can be very superficial for the simpler devices such as the key fob. It's usually simply a matter of pressing a button or pulling out a plastic tab to turn the component on and waiting for it to register with your control hub before fitting it where you want. Most components can be fitted to walls and frames using either screws or double-sided tape.

Once everything is configured and in place, it's easy to set up rules enabling your various

components to work together. We quickly created a rule where opening the front door would automatically turn on a radio plugged into the plug adaptor. We also created a rule where any movement detected by the motion sensor (£56 from www.broadbandbuyer.co.uk) near a window turned on a lamp and sent an email notification. In another example, lights plugged into the adaptor were configured to turn on automatically if the smoke detector went off, providing valuable illumination of your escape path in the event of a fire. You can also set rules to run on a schedule.

JUST FOR GOOD MEASURE

The plug adaptors keep track of power usage, so you can also use them to monitor any power-hungry appliances. Many components also measure temperature data, which you can track on a graph, so you can identify hot or cold spots if you're worried about your home insulation. Oddly, many components also track brightness, but this is shown as a meaningless percentage figure rather than something more useful such as lumens or nits.

The four-button key fob (£40 from www.morecomputers.com) and the wall switch (£43, www.kikatek.com) can be set up to manually run rules when pressed. The wall switch can be configured either as a single or double rocker switch using the included plates. These can be prised off gently using a small flat head screwdriver if you need to change the battery. One of the suggested uses for the wall switch – mounting it on your bed frame – elicited much derisive chortling in the *Shopper* office, but this can still be useful for turning on or off devices plugged into adaptors without having to get out of bed, which is handy if you're forgetful or you have mobility issues.

The smoke detector (£56, www.broadbandbuyer.co.uk) is reassuringly loud and it's tamper-resistant, too: attempting to remove it from its mounting bracket or prise open the white plastic casing will cause the alarm to sound. Sadly, there's no convenient way to silence the smoke detector, such as through the app, in false alarms; you'll have to prod the small button or waft a tea towel instead.

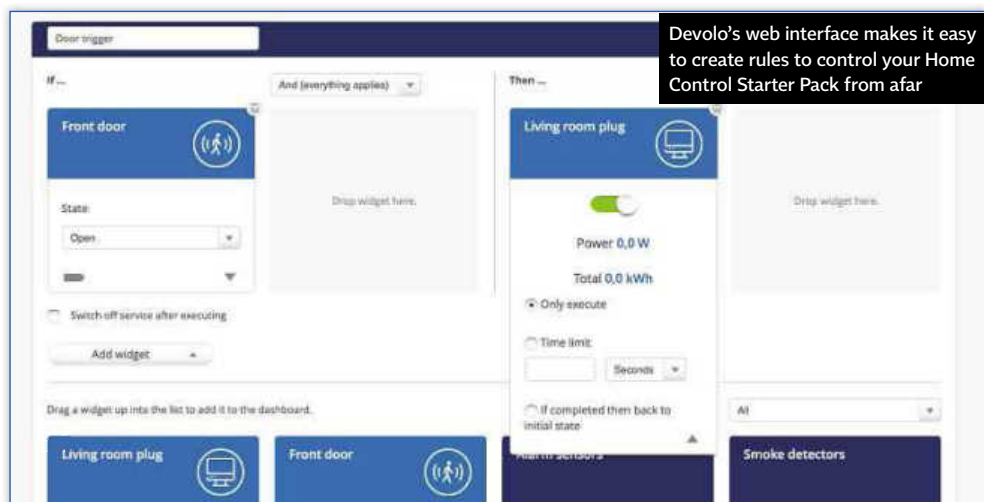
This general lack of real intelligence also extends to the thermostat (£89 for the wall-mounted room control version, £67 for the individual radiator version, both from www.broadbandbuyer.co.uk). We couldn't test it extensively as our home already has a Nest smart thermostat fitted, but the Devolo thermostat doesn't have any comparable learning features. While the ability to control the temperature remotely or schedule it are useful given the generally poor state of thermostat interface design, the lack of more advanced capabilities means Devolo's smart home kit feels more like an improved version of the home automation kits we've had for years rather than true smart home gear.

BETTER TOGETHER

Another major issue, albeit one shared with other connected home kits, is the lack of compatibility with rival smart home systems such as Works with Nest, Apple's HomeKit and Google Brillo. Devolo says it's looking into compatibility with Nest and HomeKit, but for now smart home kit is still for early adopters willing to risk buying into a system that might not be popular enough to have a wide choice of compatible components in a few years' time.

A more immediate concern is Belkin's comparably priced ZigBee-based Wemo smart home system. As well as having compatible lightbulbs (albeit not with bayonet fittings), this system also works with IFTTT for more complex rules. Devolo's Home Control Starter Pack is good, but think carefully about what you want to achieve with it before purchasing.

Alan Lu



SPECIFICATIONS

OS SUPPORT Windows 7/8/10, Ubuntu 14, Mac OS 10.7+, Android 4.0+, iOS 5+ • **TRANSMISSION SPEEDS** Ethernet 10/100, Powerline networking 200/500 • **CENTRAL UNIT RANGE** 30m (Powerline, Z-Wave indoors), 200m (Z-Wave outdoors) • **WARRANTY** Three years RTB • **DETAILS** www.devolo.com

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802.11ac WI-FI ROUTER

TP-LINK Touch P5



£135 inc VAT • From www.kikatek.com

VERDICT

A router with a touchscreen, but it's more of a gimmick than a lifesaver

ROUTERS USED TO be mysterious, esoteric, inscrutable boxes of jargon and pain. Thanks to successive generations of refinement, though, they're now much easier to configure and use than ever before. Even so, anything that makes routers more pleasurable to set up and maintain is highly desirable, so we had high hopes for the TP-Link Touch P5. This router, as its name suggests, comes equipped with a touchscreen for easy setup.

The 4.3in touchscreen has a resolution of 480x272 pixels and was responsive to our prods and swipes. Its interface looks similar to iOS, with a grid of icons acting as a home screen, and an almost identical typography and menu style. It's this familiar structure that makes the touchscreen interface easy to use.

The onscreen setup wizard isn't really any different from the browser-based wizards of rival routers. However, it is straightforward:

The onscreen setup wizard isn't really any different from the browser-based wizards of rival routers. However, it is straightforward: we had the P5 up and running in minutes

we had the P5 up and running within minutes of taking it out of the box. Almost all the router's settings, with the exception of IPv6, NAT forwarding and USB options, can be adjusted using the touchscreen.

We're not sure why you'd want to, though, as the P5's physical design generally makes it easier to do so from your computer or mobile device. For better or worse, most routers tend to live in hard-to-reach nooks and crannies, such as on top of bookcases, in entertainment centres or on hallway stands. This, combined with the screen's flat, horizontal orientation

and the fact that the router is impossible to stand upright, make hovering over it and prodding the touchscreen rather fussy and uncomfortable.

It also makes the touchscreen's one really useful feature, namely its constant display of your guest network SSID and password, less convenient for your guests than a simple Post-it note with the details scrawled on it.

There is, of course, more to the P5 than its somewhat gimmicky touchscreen. It stands out with its glossy black tessellated

appearance, although the *Shopper* office was firmly divided between those who found it attractive and others who found it a bit garish.

It has the same tabbed web administration interface as other TP-Link routers, so it's straightforward to set up, configure and administer the old-fashioned way. It also has the same extra features as other TP-Link routers, such as basic parental controls, the ability to share a USB printer or disk with all the computers on your network and threadbare Dynamic DNS support.

The router's 802.11n performance on the 2.4GHz band was pretty good, with speeds of 38Mbit/s at 10m and 27.2Mbit/s at 25m. It unsurprisingly sprang to life on the 5GHz band, speeding ahead with 167.8Mbit/s at 10m and 93.2Mbit/s at 25m.



Although the P5 isn't the fastest 802.11ac router we've seen, it did very well when paired with TP-Link's own T4UH, a chunky 802.11ac USB adaptor. Speeds of 279.6Mbit/s at 10m and 256.3Mbit/s at 25m are not to be sneezed at, especially with such a small drop in speed in the substantial move from 10m away to 25m.

Even if you have to run a mixed 802.11n/ac network on both bands, it's worth investing in an 802.11ac adaptor for your older devices stuck on previous versions of the Wi-Fi standard. Using the same T4UH adaptor on the router's 2.4GHz 802.11n network (there's no way to create a 5GHz network that isn't also 802.11ac), we saw quick speeds of 73.4Mbit/s at 10m and 36.8Mbit/s at 25m.

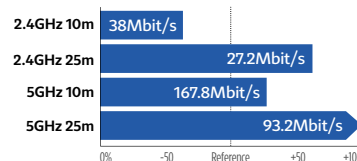
The TP-Link Touch P5 isn't a bad router, just an overpriced one. With few compelling reasons to favour the touchscreen over more traditional ways of router configuration and management, there's little reason to pay the £40 premium over TP-Link's other routers, such as the Archer C9 (see *Group Test, Shopper* 331), which are as fast or even faster.

Alan Lu

SPECIFICATIONS

MODEM None • WI-FI STANDARD 802.11ac • STATED SPEED 1,300Mbit/s • USB PORTS 1x USB3, 1x USB2 • WALL MOUNTABLE Yes • WARRANTY Two years • DETAILS uk.tp-link.com • PART CODE Touch P5

CENTRINO 802.11n



OWN ADAPTOR 802.11ac



See page 78 for performance details



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DESKTOP-PUBLISHING SOFTWARE

SERIF PagePlus X9

COMPUTER SHOPPER

★★★★★

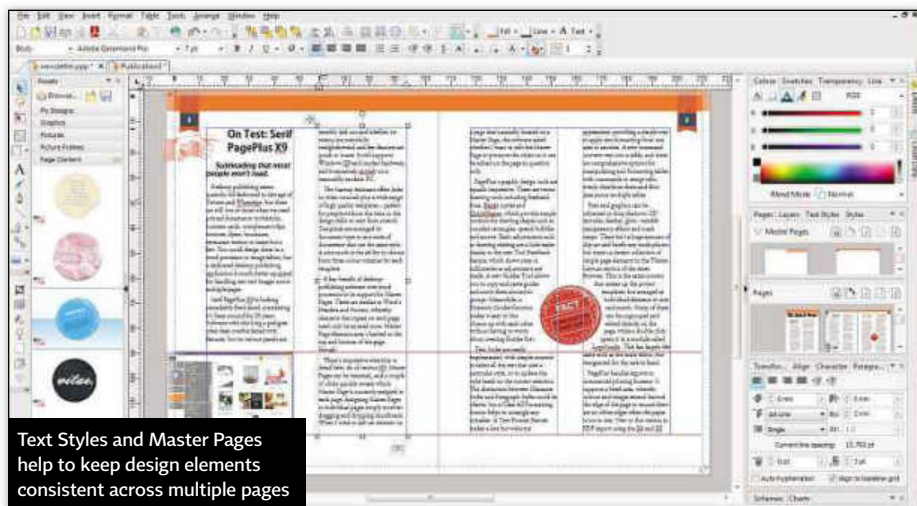
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VERDICT

Elegant and efficient, PagePlus X9 is the best desktop-publishing software around for home and small business users



Text Styles and Master Pages help to keep design elements consistent across multiple pages

DESKTOP PUBLISHING SEEMS quaintly old-fashioned in this age of Twitter and WhatsApp, but there are still lots of times we need printed documents: invitations, business cards, compliments slips, invoices, brochures, flyers and menus to name but a few. You can design them in a word processor or image editor, but a dedicated DTP application is much better equipped for handling text and images across multiple pages.

Serif PagePlus X9 looks very fresh-faced considering it's been around for 26 years. Software with this long a pedigree often feels overburdened with features, but the various panels are sensibly laid out, menus are simple and key features quick to locate. It supports Windows XP and modest hardware, and is extremely sprightly on a modern PC.

The Startup Assistant offers links to video tutorials plus a wide range of high-quality templates. Templates are arranged by type or as a suite of documents that use the same style. A nice touch is the ability to choose from three colour schemes for each template.

A key benefit of DTP software over word processors is support for Master Pages. These are similar to Word's Headers and Footers, in that elements that repeat on each page need only be entered once. Master Page elements aren't limited to the top and bottom of the page, though.

Attention to detail is impressive. Master Pages can now be renamed, and a couple of clicks quickly reveal which Master Page is

assigned to each page. Assigning Master Pages to pages simply involves dragging and dropping thumbnails. When we tried to edit a page element that was located on a Master Page, the software asked if we wanted to edit the Master Page or promote the object so it could be edited on the page in question only.

TO THE VECTOR THE SPOILS

PagePlus's graphic design tools are equally brilliant. Vector drawing tools include freehand lines, bezier curves and QuickShapes, which provide simple controls for drawing shapes such as rounded rectangles and arrows. Basic adjustments such as resizing are easier thanks to the new Tool Feedback, which shows sizes in millimetres as adjustments are made. A new Guides Tool lets you copy and paste guides and move them around in groups. Meanwhile, a Dynamic Guides function makes it easy to line up objects without creating Guides first.

Text Styles are neatly implemented, with simple controls to select all the text that uses a particular style, or to update the style based on the current selection. The distinction between Character and Paragraph Styles could be clearer, but a Clear All Formatting button helps to untangle any mistakes. A Text Format Painter provides a simple way to apply text formatting from one area to another. There are comprehensive options for manipulating tables, with commands to merge cells, evenly distribute them, and flow data across multiple tables.

Text and graphics can be subjected to drop shadows, 3D extrudes, feather, glow, variable transparency effects and mesh warps. There's very little clip art or stock photography, but there's a decent collection of simple page elements in the Theme Layouts section. This is the same content that makes up the project templates, but arranged as individual elements to mix and match. Many of these can be edited on the page, while a double-click opens it in a module called LogoStudio. This has largely the same functions as the main editor, but reorganised for the task in hand. There's a new tool to generate QR codes, and the Calendar function can now import information in iCal and other formats.

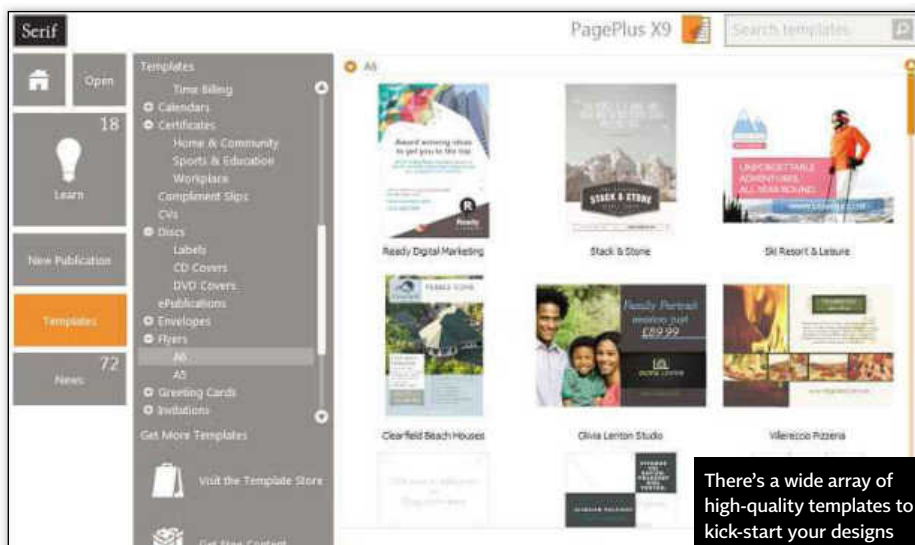
EXPORT BUSINESS

PagePlus handles exports to commercial printing bureaux. It supports CMYK colour and a bleed area, whereby colours and images extend beyond the edge of the page to ensure there are no white edges when the paper is cut to size. New to this version is PDF export using the X4 and X5 standards that ensure high-quality output for printing. The software can also open and edit existing PDFs.

It's not often we write this, but there isn't much we can fault about this software. It's not possible to export as a JPEG and include the bleed area, but that is unlikely to bother most users. A library of photos would be handy, but in practice, anything short of thousands of images tends to fall short when you're looking for the perfect image. As with any other DTP application, PagePlus users are better off with online image libraries such as Adobe Stock.

There isn't much competition for PagePlus at this price. The strongest contender is Xara Page & Layout Designer 11, a close relative of the superb Xara Photo & Graphic Designer (see *Shopper* 334) but with fewer illustration features and more DTP features. Xara and Serif's DTP applications have a lot in common, but for us, Serif PagePlus is more polished, particularly in its handling of Master Pages and Text Styles. It's a Best Buy.

Ben Pitt



There's a wide array of high-quality templates to kick-start your designs

SPECIFICATIONS

OS SUPPORT Windows XP/Vista/7/8/10 • **MINIMUM CPU** SSE2 support • **MINIMUM GPU** Not stated • **MINIMUM RAM** 512MB, 2GB for Windows 7/8/10 • **HARD DISK SPACE** 1.66GB • **DETAILS** www.serif.com

PAINTING SOFTWARE

COREL Painter 2016



£311 inc VAT • From www.amazon.co.uk

VERDICT

Sophisticated and rewarding, Painter is worth the expense for technically minded artists

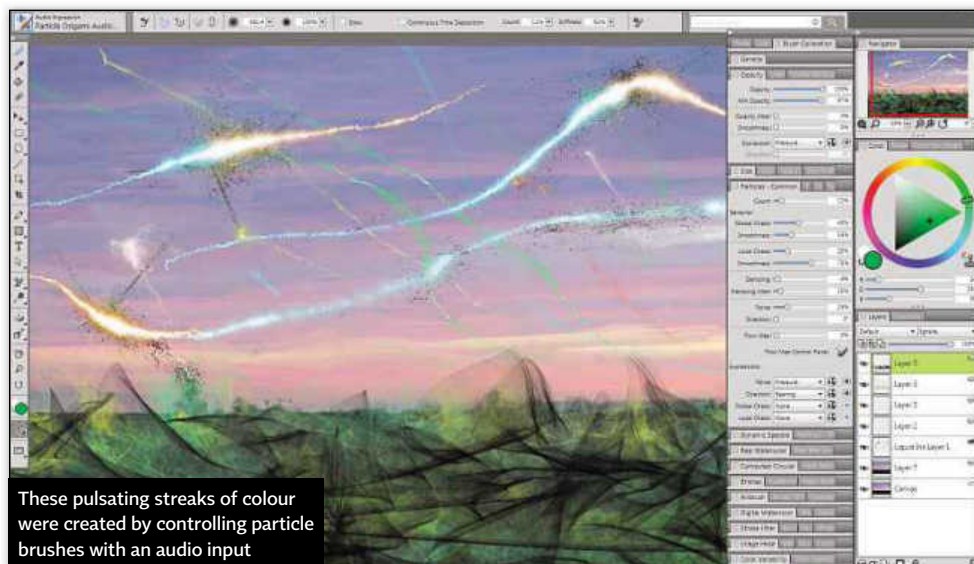
MOST SOFTWARE FOR graphic designers tries to be a jack of all trades, so it's nice to see something that aims to do one job well. Corel Painter specialises in digital painting, with emulations of natural media such as oil, pastels and watercolours, plus some brushes that have no real-world equivalent.

At a basic level, it's a bitmap editor, with brush strokes saved as pixels on the virtual page rather than vector coordinates. However, the only time you're likely to import photos is to use them as a basis for a painting; smearing colours in a photo produces digital paintings in record time.

There are some superb painting apps for iOS and Android, such as Procreate, ArtRage and Brushes, which cost £4.49, £4 and nothing respectively, so why pay £311 for Corel Painter? The answer, Corel hopes, lies in the sophistication of its brush technology.

The Property Bar handles basics including size and opacity. Delving into the 40 brush control panels reveals hundreds more options such as bristle rigidity, brush wetness, water viscosity and evaporation rate. There are jitter settings to randomise parameters, plus the ability to vary parameters according to the speed, pressure or direction of brush strokes.

Painter needs to be used with a pressure-sensitive input device for best results, as the ability to respond to pen pressure breathes life into brush strokes. Pressure-sensitive touchscreens are few and far between unless you want to splash out on one of Wacom's high-end Cintiq displays, but Wacom's Intuos drawing tablets and Microsoft's Surface Pen for Surface 3 and Surface Pro 3 are other options. Corel tells us it has worked closely with Microsoft to ensure that Surface and Painter work well together. We were able to resurrect an old Wacom Graphire4 graphics tablet, which did the job nicely.



This latest update introduces a new input type called Audio Expression. It uses an audio input, such as a microphone, or the system audio – most likely some music – and turns the volume envelope into a controller. This can be mapped to a wide range of parameters including size, opacity, grain, angle and colour.

We're not convinced by Corel's suggestion that this channels the emotion of music into an artwork. It's also disappointing that there's no Smoothness control – the tracked audio volume jumps from one value to the next at a low sample rate. Even so, making noises into a headset microphone while painting added a welcome extra level of control. With Opacity mapped to pen pressure and brush size mapped to the audio input, we were able to take precise control over brush strokes.

A BRUSH AND A PUSH

With so much editing depth, it's a relief to find a well organised collection of brush presets. There are 800 in total, including 131 new ones and 438 legacy brushes that are hidden from view but remain available for backwards compatibility. The 362 others are organised into 27 categories such as Artists Oils, Markers, Liquid Ink and Watercolour.

Some of the brushes are disappointing but we really liked the four that also employed the particle feature introduced in Painter 2015. These use multiple points – or particles – that move in complex ways as they apply colour to the canvas. They have more in common with particle generators used to create smoke and fire effects in animation software such as HitFilm Pro than the bristles in Painter's other brush types. Here, they produce sparks and

explosions, and also come in handy for fur effects and other rich, organic textures. Combining particle brushes with Audio Expression produces some richly dynamic and expressive brushes that are a pleasure to use.

Various other new brush types combine particle technology with more conventional Painter features such as bristle thickness. In particular, the brushes in the Dynamic Speckle category are among the most impressive brushes for natural media effects.

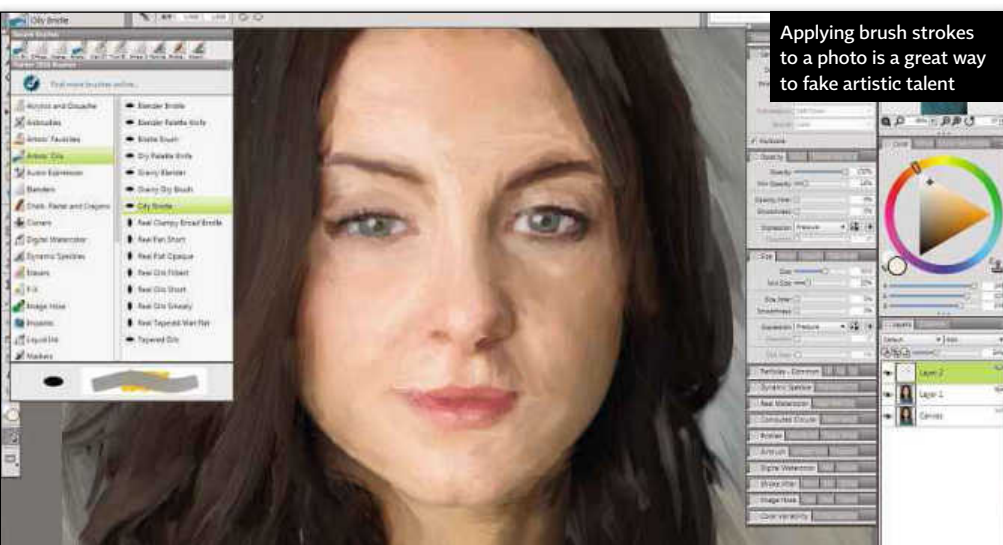
TAKE THE HINT

A revamped interface is listed among the new features. Brush Hints are welcome, providing an explanation for a control as you hover over it. These are included for the newer and more complex controls only; it's a shame they're not available for all. A new Presentation mode clears the screen to show only the canvas, and lets you change the interface colour.

Overall, the interface is good, rather than great. Technically minded users will appreciate direct control over a vast number of parameters, while others will be content with the brush presets and basic controls in the Property Bar. We'd like to see a middle-level control system, where the detailed parameters were managed via a graphical control panel that lets users select brushes and paint, mix colours, add water and wash brushes in a manner more in keeping with the real thing.

Painter 2016 is extremely impressive. The new particle-based brushes in particular are fantastic for computer game production and other forms of 3D animation, where texture maps are painted on to 3D models. Graphic designers will appreciate the ability to add some colour and texture to designs with just a few well-placed strokes. Fine artists will find a huge amount to keep them busy. Not everyone will be won over by Audio Expression, but we're sold. It's a big investment at over £300, but the 30-day trial should be enough to reel people in.

Ben Pitt



SPECIFICATIONS

OS SUPPORT Windows 7/8/10 • **MINIMUM CPU** Pentium 4 (Core 2 Duo recommended) • **MINIMUM GPU** Not stated • **MINIMUM RAM** 2GB (4GB recommended) • **HARD DISK SPACE** 750MB • **DETAILS** www.painterartist.com

ACTION ADVENTURE GAME

SQUARE ENIX

Rise of the Tomb Raider



£40 inc VAT •

From store.steampowered.com

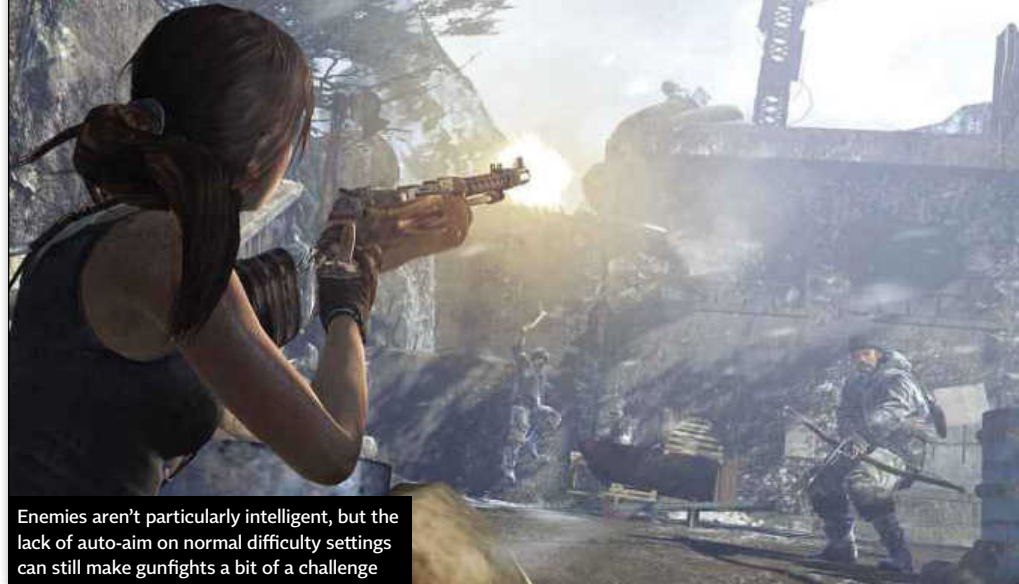
VERDICT

Great fun, but Rise of the Tomb Raider fails to unearth Lara's true potential

LARA CROFT HAS come a long way since she first appeared in 1996, but the complex puzzles that defined her earlier escapades have become progressively less important with each new entry. Crystal Dynamics' latest reboot series practically ditches the titular tombs altogether. Instead, it's followed in the footsteps of its closest competitor, Naughty Dog's Uncharted series, with a greater emphasis on shooting. It was a potent mix that worked well in 2013's Tomb Raider, and this instalment in Lara's new, gritty origins story follows very much the same template.

Lara is once again portrayed as a young and inexperienced adventurer, but her attacks and finishers are no less brutal than before. There's a greater emphasis on stealth here compared to her last expedition, and you can often clear out large groups of myopic, idiotic enemies with just a few well-placed arrows.

Lara has also taken lessons from Naughty Dog's other big hitter, The Last of Us, and can now throw together a variety of improvised explosives on the fly. If you see a bottle or a tin can, you can quickly build a Molotov or grenade to fling at your opponents – albeit at the cost of the resources you carry with you. You can't store such items to use at will, though, which cleverly



Enemies aren't particularly intelligent, but the lack of auto-aim on normal difficulty settings can still make gunfights a bit of a challenge

allows the developer to keep a rein on their use, even if it doesn't make much sense.

It's worth noting that there's no auto-aim system on the default difficulty level, which can make lining up shots with the bow rather tricky under pressure. The Xbox One controller has excellent analogue sticks but we found survival in some encounters was down to luck rather than skill. PC owners have the option of using a mouse and keyboard instead, which we found was much more accurate and comfortable. However, we'd still prefer a slightly stickier aim and tougher opponents given the choice.

CROFT ORIGINAL

Between the fighting there's a healthy dose of exploration, with lots of opportunities to climb about on trees, roofs and rock faces. Most of this is utterly unchallenging, but one tricky platforming section, with jumps that require actual timing, proves the developers could have got more out of Lara's athleticism.

It's a shame the climbing and shooting sections don't quite gel; it's largely one then the other, rather than hanging off a cliff face popping bullets one-handed. From what we've seen of the new Uncharted, Nathan Drake will mix it up more and to greater effect.

There are some cracking puzzles in the game, the best involving both water and Lara's expanded ability to fire rope arrows and attach them to various objects, as well as cut them free again using a knife. Unfortunately, most puzzles are restricted to single, large rooms that aren't woven into the plot itself, instead forming extra bonus missions that dole out extra practical abilities.

It's hard to know if the strong similarities between this game and the last are partly due to it being available on the Xbox 360 as well as Xbox One and PC, and whether a purely current-gen title could have spread

its wings a little wider in terms of scale and depth. That said, the Xbox One's extra horsepower has been put to good use in the visuals, and the epic backdrops, dense, driving snow and individual footprints look even better on PC. Ice glistens and cracks just how you'd expect, and Lara's shiny, luxuriant hair slips and slides over

her shoulders in an uncannily realistic way, almost warranting its own Pantene advert.

The RPG elements of the game return, with skills to upgrade and natural resources to find and craft into useful items. We made little effort to look for these or hunt animals other than those that stumbled across our path, but we still found the game largely manageable bar a couple of difficulty spikes in certain fights. On harder difficulty levels, these systems no doubt come into their own as you scramble around for resources, but for your average adventurer it's rather disappointing that you're not required to engage with them more effectively.

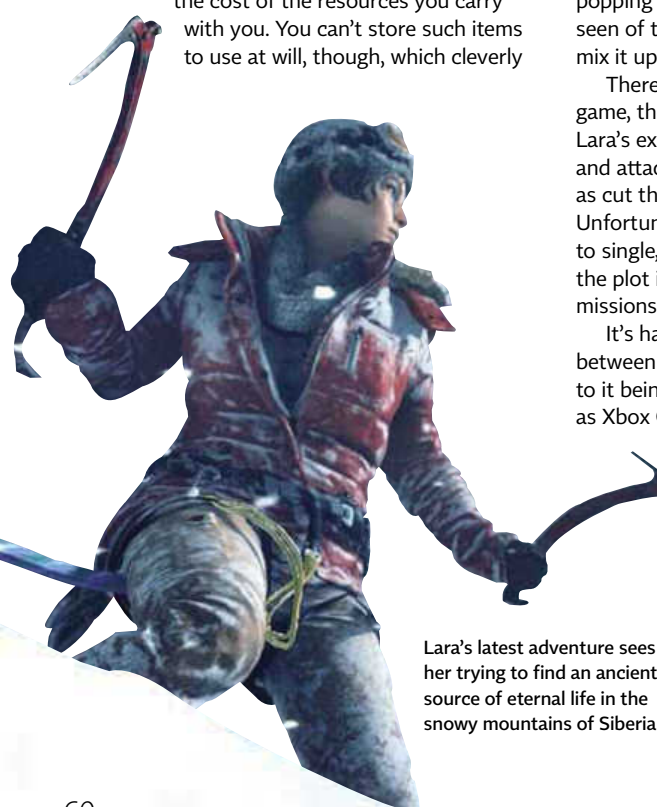
PACE MAKER

The plot is a bit so-so with an ancient artefact to find and protect, and a hidden valley where war is being waged between interested factions, but the game's pacing is superb. Narrow spaces and short cutscenes disguise any loading times, so each level flows beautifully from one to the other, and when the action just keeps coming, you don't really mind that the narrative is rather unsatisfying.

Lara's also more convincing as a budding archaeologist this time round, and she even comments on items of interest. It's a bit daft that you can 'level up' her ancient language skills simply by engaging with various murals and monoliths, but at least she doesn't destroy every single pot she walks near any more.

Rise of the Tomb Raider may borrow many traits from some of the biggest franchises around, but there's no denying Lara has her own distinct take on the all-action adventure genre. It does re-tread a lot of old ground, and it's a shame the game's shooting, climbing and puzzling elements aren't blended into a single, more satisfying whole, but it's still an incredibly slick, immensely enjoyable, thrill-packed ride that anyone will enjoy.

Seth Barton



Lara's latest adventure sees her trying to find an ancient source of eternal life in the snowy mountains of Siberia

SPECIFICATIONS

AVAILABLE FORMATS Xbox One, Xbox 360, PC • **OS**
SUPPORT Windows 7/8/10 • **MINIMUM CPU** Intel Core
 i3-2100 or AMD equivalent • **MINIMUM GPU** Nvidia
 GeForce GTX 650 2GB, AMD Radeon HD 7770 2GB •
MINIMUM RAM 6GB • **HARD DISK SPACE** 25GB •
DETAILS www.tombraider.com

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ONLINE SHOOTER

UBISOFT

Tom Clancy's Rainbow Six Siege



£40 inc VAT •

From store.steampowered.com

VERDICT

Visceral multiplayer shooting, but the basic single-player content limits its appeal

WHEN IT COMES to tactical online shooters, it was always going to take something special to dethrone Valve's juggernaut FPS, Counter Strike, but the latest incarnation of the Rainbow Six series just breach-and-cleared its way into the spotlight. Siege is a multiplayer-focused, 5v5 tactical shooter that borrows from Counter Strike and, bizarrely, action strategy games such as Dota 2 and Heroes of the Storm. The combination shouldn't work, but it results in some of the most intense gunfights and strategic planning of any shooter released over the last year.

Siege is asymmetrical, with teams taking turns to play as defenders and attackers. On defence, you have 30 seconds at the start of each round to board windows, barricade walls and set traps to catch out the attacking team. While this is happening, the attacking side can use their remote-controlled recon drones to search the map for enemies and their main objective. They can also choose from multiple points of entry, surprising defenders with a rooftop breach, rappel through a window or sniper shot from an adjacent rooftop.

There are 11 maps available, with more to come later this year, including inner-city banks, suburban mansions, Swiss chalets, diplomatic consulates, an SAS training ground and a grounded Air Force One. Most focus on close-quarters combat, so players have to work in teams to clear a safe route to the objective. This could be a bomb to defuse, a hostage to rescue, or room to control.

It's the destruction that truly makes each match a nail-biting affair. The defenders might have barricaded all the windows, but the



Interior walls are rarely safe; well-placed shots will rip right through plasterboard and wood

hastily thrown together plywood panels can't withstand more than a few hits before splintering apart. You can also create your own entrances using breaching charges, C4 and nitrocells, demolishing walls, floors and ceilings in a shower of dust and debris to get the drop on the opposing team.

IF LOOKS COULD KILL

It all looks stunning, whether at 1080p and 60fps on the PS4 and Xbox One, or at up to 4K resolutions (with an optional Ultra HD texture pack) on a PC. Many maps are playable as daytime or night-time variants, too, which let the lighting effects really shine. However, Siege doesn't have the same level of polish as other recent triple-A releases. This may be a result of the destruction effects placing extra strain on console hardware, as some maps look particularly bare when you turn your eyes away from the action.

Players can take only a few shots before falling, and with no respawning mid-round, you're forced to ask your teammates to pick you back up to carry on fighting. Once you're out, you can continue using any fixed cameras or active recon drones to spot enemies, calling out their positions to your teammates in order to turn a losing round into a win.

It's the tactical challenge of picking the right operator for the task that makes Siege stand out from other shooters, particularly when it comes to spectating and possible eSports success. There are 20 characters to choose from, each with different weapons, perks, abilities and equipment. Electronics specialist Twitch, for example, is equipped

with a remote-controlled drone that can stun enemies with an electronic pulse. Smoke, meanwhile, can detonate poison gas canisters that slowly incapacitate any foe that strays into the blast cloud. Once selected, you have to use your chosen operator for the entire match – there's no changing at half-time. This encourages teams to balance offensive and defensive roles, and can force players to switch from a preferred play style if it doesn't suit a particular map or mission objective.

COMMS TOGETHER

When all these elements are combined, it makes communication the key to success. If you aren't spotting enemies, setting up defences and resupplying your teammates, you can get quickly overrun by a more organised opponent. Siege is at its best when you play regularly with a squad of friends; the kind of quick, clear communication that only comes with regular play is crucial.

However, this multiplayer focus will leave solo gamers feeling left out. There's no campaign mode, only a selection of 'Situation' missions that play out as an introduction to the game's many mechanics. They can be completed in under an hour, and aren't too challenging. There's a cooperative Terrorist Hunt mode as well, which can also be played alone, but the constant waves of enemies quickly get repetitive, regardless of whether you're playing as attackers or defenders.

Whether Siege justifies a full-price release will depend entirely on how seriously invested you plan on becoming. There's effectively only one multiplayer mode, and while that isn't an issue for MOBAs such as League of Legends, those are free-to-play rather than £40. Siege has real potential as an eSports title, if players and tournaments get behind it, but unless you plan on making it your main online shooter, it's one to wait for in the sales.

Tom Morgan



Why take the door, when you can rappel down from the roof and burst in through a window?

SPECIFICATIONS

AVAILABLE FORMATS PC, Xbox One, PS4 • **OS SUPPORT** Windows 7, Windows 8.1, Windows 10 64-bit • **MINIMUM CPU** Intel Core i3 560 3.3GHz, AMD Phenom II X4 945 3.0GHz • **MINIMUM GPU** Nvidia GeForce GTX 460, AMD Radeon HD 5870 • **MINIMUM RAM** 6GB • **HARD DISK SPACE** 30GB • **DETAILS** www.ubisoft.com



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Whether you're an IT professional or a first time buyer, Dennis technology has a magazine for you, all of which are written and produced by expert editorial teams.

We cover the whole spectrum of technology news, reviews and features.

Choosing a... PC system

01 A basic PC costing around £350 will be able to run everyday office, multimedia and education software and will easily cope with surfing the internet. It might even be able to run some modern games.

Many PCs can be sold either with or without a monitor. If you don't like the display that the manufacturer is offering, you can always use your current one, or buy another one separately.

02 If you want to play games, you'll have to upgrade the graphics card. Budget cards such as the Nvidia GeForce GTX 950 will cope well with many 3D games, but to play the latest 3D games smoothly (and enjoy the best-quality graphics) it's worth upgrading to a more powerful card such as the Nvidia GeForce GTX 970.

03 All modern PCs come with at least a dual-core processor and are capable of most tasks. Anyone who regularly undertakes demanding tasks such as video editing and encoding should consider a quad-core or even a hex-core processor.

04 There are plenty of good reasons to upgrade the PC's memory or hard disk. If you'll use your PC for gaming, video editing or other demanding tasks, you'll need 8GB of RAM and a large hard disk; 1TB should suffice. Many new PCs come with an SSD, which speeds up the time it takes for your PC to boot and programs to load.

05 Having plenty of USB ports is always useful, as most computer

peripherals attach to these ports. Most new PCs come with the latest USB3 ports, which provide faster data transfers when used with supported devices than the older USB2 standard.

06 Most new PCs now come with Windows 10 pre-installed. Don't be too easily swayed by the inclusion of other software, though, as it may be that you'll never use it.

07 While most PCs come in cases of a similar size, some have more compact mini tower or mini PC cases. These smaller PCs will fit under your TV or on your desk more easily, but bear in mind that they're significantly harder to upgrade than full-size machines.

PCs

PALICOMP AMD Shockwave

★★★★★

£500 inc VAT • www.palicom.co.uk

COMPUTER SHOPPER
BEST BUY

While its AMD processor can't match the best Intel chips, Palicom has pushed the boat out elsewhere, with a decent 4GB AMD R7 370 graphics card, delivering credible gaming performance at Full HD resolutions. You can't get much better for the money.



PROCESSOR Quad-core 4GHz AMD Athlon X4 860K (overclocked) • **RAM** 8GB • **FRONT USB PORTS** 2x USB3 • **REAR USB PORTS** 4x USB2, 2x USB3 • **TOTAL STORAGE** 1TB hybrid hard disk • **GRAPHICS CARD** 4GB AMD Radeon R7 370 • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** Three years RTB • **DETAILS** www.palicom.co.uk • **PART CODE** KAV2 • **FULL REVIEW** Jan 2016

YOYOTECH Warbird RS10

★★★★★

£700 inc VAT • www.yoyotech.co.uk

COMPUTER SHOPPER
BEST BUY

If you're after the complete package, Yoyotech has managed to squeeze in everything you'll need for a mid-range gaming PC, including a powerful quad-core processor, mid-range graphics and a decent monitor. Yoyotech has updated the chassis since our review, but kept the price the same.



PROCESSOR Quad-core 4.4GHz Intel Core i5-6600K (overclocked) • **RAM** 8GB • **FRONT USB PORTS** 2x USB3 • **REAR USB PORTS** 6x USB3 • **TOTAL STORAGE** 1TB hard disk • **GRAPHICS CARD** 2GB Nvidia GeForce GTX 960 • **DISPLAY** 22in Iiyama ProLite E2283HS • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** Three year (one year parts & labour RTB, two year labour RTB) • **DETAILS** www.yoyotech.co.uk • **PART CODE** ER0815WRS10 • **FULL REVIEW** Nov 2015

SCAN 3XS Z170 Performance GTK6

★★★★★

£1,046 inc VAT • www.scan.co.uk/3xs

COMPUTER SHOPPER
BEST BUY

An incredibly powerful Skylake system that can cope with just about any desktop task and handle gaming at 2,560x1,440. The Z170 motherboard is future-proof too, with USB3.1 and an M.2 slot for PCI-Express storage.



PROCESSOR Quad-core 4.6GHz Intel Core i5-6600K (overclocked) • **RAM** 8GB • **FRONT USB PORTS** 4x USB3 • **REAR USB PORTS** 2x USB3.1, 1x USB Type-C, 2x USB2 • **TOTAL STORAGE** 256GB SSD, 1TB hard disk • **GRAPHICS CARD** 4GB Nvidia GeForce GTX 970 • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** Three years parts cover: first year onsite, years two and three RTB • **DETAILS** www.scan.co.uk/3xs • **PART CODE** Performance Z170 GTK6 • **FULL REVIEW** Nov 2015

APPLE 27in iMac with 5K Retina Display

★★★★★

£1,599 inc VAT • www.apple.com/uk

COMPUTER SHOPPER
RECOMMENDED

It's not often Apple represents best-in-class value, but the 5K iMac is an exception. It has the best screen we've seen on an all-in-one, along with the best processor performance and some handy graphics capabilities.



PROCESSOR Quad-core 3.2GHz Intel Core i5-6500 • **RAM** 8GB • **FRONT USB PORTS** 0 • **REAR USB PORTS** 4x USB3 • **TOTAL STORAGE** 1TB fusion drive • **GRAPHICS CARD** AMD Radeon R9 M390 • **DISPLAY** Apple 27in integrated • **OPERATING SYSTEM** Apple OS X 10.11 El Capitan • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** 27-inch iMac • **FULL REVIEW** Feb 2016

Choosing a... Laptop

01 A basic laptop costing around £300 will run everyday office, multimedia and education software, but it won't be suitable for 3D gaming or processor-intensive tasks such as video editing. Many laptops at this price have a 15.4in screen and weigh around 2.4kg, so they're best used around the house and for occasional journeys.

02 If you want to play modern games, you'll need a laptop with a dedicated graphics chip such as the Nvidia GeForce GTX 960M. Good gaming laptops tend to have large 17in screens and weigh around 3kg, so they're best suited to use at home.

03 If you want a laptop that you can take everywhere, look for a model

that weighs less than 2kg. For the best portability, buy one that has an 11in or 13in screen. In general, the smaller and lighter the laptop, the more expensive it is, especially if it has plenty of processing power.

04 Battery life is extremely important for a laptop, particularly if you'll be carrying it around. We'd expect all but the biggest and heaviest to last for at least five hours on a single charge, but for an ultra-portable that you carry everywhere, eight hours and above is more desirable.

05 Laptops use mobile versions of processors to conserve power, and these lag behind desktop chips when it comes to performance. For a budget laptop, an Intel Core i3 processor will do the

job perfectly adequately, but if you want better performance, you should look for an Intel Core i5 or Core i7 model instead. We recommend a minimum of 4GB of RAM, although 8GB is better for multitasking.

06 Most budget and mid-range laptops use a mechanical hard disk for storage. You'll want at least 500GB, but 1TB or more is better. Solid-state drives (SSDs) have faster performance, making your computer quicker to boot and more responsive. They have lower capacities, though. You'll need at least 128GB.

07 Netbooks are a type of small, low-cost ultra-portable laptop. They're fine for light use, but avoid them if you want to do complicated tasks.

LAPTOPS

DELL XPS 13

★★★★★

£1,149 inc VAT • www.dell.co.uk

COMPUTER SHOPPER
BEST BUY

The latest Dell XPS 13 is a stunning piece of engineering. While visually it's not changed much from previous versions, its InfinityEdge screen's almost non-existent bezels look beautiful and there have been excellent internal upgrades, including a new Intel Skylake processor.



PROCESSOR Dual-core 2.5GHz Intel Core i7-6500U • **RAM** 8GB • **DIMENSIONS** 304x200x15mm • **WEIGHT** 1.29kg • **SCREEN SIZE** 13.3in • **SCREEN RESOLUTION** 3,200x1,800 • **GRAPHICS ADAPTOR** Intel HD Graphics 520 • **TOTAL STORAGE** 256GB SSD • **OPERATING SYSTEM** Windows 10 Home • **PARTS AND LABOUR WARRANTY** One year collect and return • **DETAILS** www.dell.com • **PART NUMBER** CNX9305 • **FULL REVIEW** Mar 2016

TOSHIBA Satellite Radius 15

★★★★☆

£700 inc VAT • www.currys.co.uk

COMPUTER SHOPPER
RECOMMENDED

Recently updated with more RAM and an Intel Skylake processor, the refreshed Radius 15 retains the high-quality screen, great battery life and stylish chassis. It's a great way to take advantage of Windows 10's touchscreen elements, too.



PROCESSOR Dual-core 2.3GHz Intel Core i5-6200U • **RAM** 16GB • **DIMENSIONS** 380x245x20mm • **WEIGHT** 2.3kg • **SCREEN SIZE** 15.6in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Intel HD Graphics 520 • **TOTAL STORAGE** 1TB SSHD • **OPERATING SYSTEM** Windows 10 Home • **PARTS AND LABOUR WARRANTY** One year RTB • **DETAILS** www.toshiba.co.uk • **PART NUMBER** P50W-C-10P • **FULL REVIEW** Dec 2015

TOSHIBA Chromebook 2 (CB30-B-104)

★★★★☆

£270 inc VAT • www.johnlewis.com

COMPUTER SHOPPER
RECOMMENDED

The first budget Chromebook on sale in the UK to have a Full HD screen is a bit more expensive than the competition, but we think it's absolutely worth it. With so much extra space, you can fit more items on the screen and get more done.



PROCESSOR Dual-core 2.16GHz Intel Celeron N2840 • **RAM** 4GB • **DIMENSIONS** 320x214x19mm • **WEIGHT** 1.35kg • **SCREEN SIZE** 13.3in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Intel HD Graphics • **TOTAL STORAGE** 16GB SSD • **OPERATING SYSTEM** Google Chrome OS • **PARTS AND LABOUR WARRANTY** One year RTB • **DETAILS** www.toshiba.co.uk • **PART CODE** PLM02E-00D003EN • **FULL REVIEW** May 2015

MSI GE72 6QF Apache Pro

★★★★☆

£1,230 inc VAT • www.saveonlaptops.co.uk

COMPUTER SHOPPER
RECOMMENDED

The MSI GE72 6QF Apache Pro is an eminently powerful gaming laptop with top specifications, including the latest Intel Skylake processor. There's a top-notch Nvidia GeForce 970M graphics card, which can tackle even the most taxing games.



PROCESSOR Quad-core 2.6GHz Intel Core i7-6700HQ • **RAM** 16GB • **DIMENSIONS** 383x260x27mm • **WEIGHT** 2.7kg • **SCREEN SIZE** 17.3in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Nvidia GeForce GTX 970M • **TOTAL STORAGE** 128GB SSD, 1TB hard disk • **OPERATING SYSTEM** Windows 10 Home • **PARTS AND LABOUR WARRANTY** Two years collect & return • **DETAILS** uk.msi.com • **PART CODE** GE72 6QF-014UK • **FULL REVIEW** Feb 2016

Choosing a... Smartphone

01 A smartphone's operating system (OS) dictates its basic features and which third-party software you can install. There are three main contenders: Apple's iOS, which is found on the iPhone, Google's Android, which is used by various handset manufacturers, and Windows Phone 8, which is mainly used on Lumia phones. Apple iOS and Google Android have the most apps available but Windows Phone is slowly catching up.

02 All smartphones have colour screens, but their resolutions vary. Basic models have 800x480 pixels, but text can be indistinct. Look for a display that has at least 1,280x720 pixels so it's easy to browse web

pages. Don't worry too much about built-in media players or Office document editors; you can always install apps to replace these with better versions later.

The image quality of smartphone cameras has improved tremendously in recent years, and resolutions have increased to as high as 20 megapixels.

03 Very few modern smartphones have a physical keyboard for entering text; they almost exclusively use touchscreens now. Physical keyboards can aid heavy emailing, but today's touchscreen keyboards work just as well.

Android smartphones and iPhones running iOS 8 or 9 allow you to install a

variety of custom onscreen keyboards so you can find one that suits you.

04 Be careful when choosing a contract. Look for one that includes a large data allowance if you want to use the internet regularly or you've set your phone to synchronise your contacts, calendar and email through online services.

Built-in Wi-Fi can help you avoid high data charges by connecting to the internet through wireless hotspots when you're out, or your router when you're at home. Android and iPhone handsets can operate as wireless hotspots, letting you connect your laptop to the web over your mobile data connection. There may be an extra charge for this.

SMARTPHONES

MOTOROLA Moto X Force

★★★★★

£480 SIM-free; free on £31.50-per-month contract • www.carphonewarehouse.com (SIM-free), www.idmobile.co.uk (contract)

COMPUTER SHOPPER
BEST BUY

With its incredible shatterproof display, you need never worry about dropping your phone ever again with the Moto X Force. It also has great battery life and a super-fast processor.



PROCESSOR Octa-core 2GHz Qualcomm Snapdragon 810 • SCREEN SIZE 5.4in • SCREEN RESOLUTION 2,560x1,440 • REAR CAMERA 21 megapixels • STORAGE 32GB • WIRELESS DATA 4G • DIMENSIONS 150x78x7.6mm • WEIGHT 169g • OPERATING SYSTEM Android 5.1 • DETAILS www.motorola.co.uk • PART CODE XT1580 • FULL REVIEW Mar 2016

SAMSUNG Galaxy S6

★★★★★

£380 SIM-free; free on £26-per-month on contract • www.carphonewarehouse.com (SIM-free and contract)

COMPUTER SHOPPER
RECOMMENDED

The all-metal Galaxy S6 is Samsung's best phone yet. Performance is fantastic and the 2,560x1,440 screen looks gorgeous. The curvy Galaxy S6 Edge is a head-turning alternative.



PROCESSORS Quad-core 2.1GHz & quad-core 1.5GHz Samsung Exynos 7420 • SCREEN SIZE 5.1in • SCREEN RESOLUTION 2,560x1,440 • REAR CAMERA 16 megapixels • STORAGE 32GB • WIRELESS DATA 4G • DIMENSIONS 143x70x6.8mm • WEIGHT 132g • OPERATING SYSTEM Android 5.0 • WARRANTY One year RTB • DETAILS www.samsung.com/uk • PART CODE SM-G920F • FULL REVIEW Jul 2015

APPLE iPhone 6

★★★★★

£459 SIM-free; free on £32-per-month contract • www.apple.com/uk (SIM-free), www.carphonewarehouse.com (contract)

COMPUTER SHOPPER
BEST BUY

A larger screen, faster processor and improved battery life make the iPhone 6 a huge improvement over the iPhone 5s, and it's now even cheaper as Apple makes way for the new iPhone 6s.



PROCESSOR Dual-core 1.4GHz Apple A8 • SCREEN SIZE 4.7in • SCREEN RESOLUTION 1,334x750 • REAR CAMERA 8 megapixels • STORAGE 16GB • WIRELESS DATA 4G • DIMENSIONS 138x67x6.9mm • WEIGHT 129g • OPERATING SYSTEM iOS 9 • WARRANTY One year RTB • DETAILS www.apple.com/uk • PART CODE iPhone 6 • FULL REVIEW Dec 2014

GOOGLE Nexus 5X

★★★★★

£300 (SIM-free); free on £19.50-per-month contract • www.carphonewarehouse.com (SIM-free), www.idmobile.co.uk (contract)

COMPUTER SHOPPER
BEST BUY

It might not be the prettiest phone around, but the Nexus 5X is quick, has a great camera and comes with Android 6.0 Marshmallow.



PROCESSOR Hexa-core 1.8GHz Qualcomm Snapdragon 808 • SCREEN SIZE 5.2in • SCREEN RESOLUTION 1,920x1,080 • REAR CAMERA 12.3 megapixels • STORAGE 16GB • WIRELESS DATA 4G • DIMENSIONS 147x73x7.9mm • WEIGHT 136g • OPERATING SYSTEM Android 6.0 • WARRANTY One year RTB • DETAILS www.google.com/nexus/5x • PART CODE Nexus 5X • FULL REVIEW Feb 2016

MOTOROLA Moto G (3rd Gen)

★★★★★

£150 (SIM-free); free on £13.50-per-month contract • www.carphonewarehouse.com (SIM-free), www.idmobile.com (contract)

COMPUTER SHOPPER
RECOMMENDED

The 3rd Gen Moto G has an improved camera, longer battery life and an all-new design, making it our go-to budget smartphone.



PROCESSOR Quad-core 1.2GHz Qualcomm Snapdragon 410 • SCREEN SIZE 5in • SCREEN RESOLUTION 1,280x720 • REAR CAMERA 13 megapixels • STORAGE 8GB • WIRELESS DATA 4G • DIMENSIONS 142x72x6.1mm • WEIGHT 155g • OPERATING SYSTEM Android 5.1.1 • DETAILS www.motorola.co.uk • PART CODE XT1541 • FULL REVIEW Dec 2015

VODAFONE Smart Ultra 6

★★★★★

£115 (PAYG); free on £17-per-month contract • shop.vodafone.co.uk (PAYG and contract)

COMPUTER SHOPPER
BEST BUY

A mid-range smartphone at an entry-level price. Packed with an octa-core processor, a huge Full HD display and a great camera, the Smart Ultra 6 is unbelievably good value.



PROCESSOR Octa-core 1.7GHz Qualcomm Snapdragon 615 • SCREEN SIZE 5.5in • SCREEN RESOLUTION 1,920x1,080 • REAR CAMERA 13 megapixels • STORAGE 16GB • WIRELESS DATA 4G • DIMENSIONS 154x77x8.4mm • WEIGHT 159g • OPERATING SYSTEM Android 5.0.2 • WARRANTY One year RTB • DETAILS www.vodafone.co.uk • PART CODE Smart Ultra 6 • FULL REVIEW Nov 2015

Choosing a... Tablet

01 All tablets rely on an operating system (OS) to run apps. You have three main choices: Apple's iOS, which runs on the iPad, Android, which Google licenses to various manufacturers, and Windows 10, which is slowly becoming more common in hybrid tablets and convertibles. If you own an Apple or Google smartphone, you can download your apps, music and so on to a tablet that runs the same OS, so it makes sense to stick with a compatible device.

02 It's important to pick a tablet that has a good-quality high-resolution screen. Many budget tablets have 1,280x800-resolution displays, but better tablets have Full HD 1,920x1,080 panels, and we're

starting to see tablets that have even higher screen resolutions. Some are as high as 2,560x1,600 or even 4K. Entry-level tablets typically use TN panels, which don't have particularly good viewing angles. The viewing angles of IPS panels are much better.

03 If you want to listen to music, watch films and play games, make sure your tablet has plenty of storage. Many tablets come with 8GB or 16GB of internal storage, although some budget models have less. You'll typically pay more for a higher storage capacity. Many tablets also have microSD slots that let you add extra storage, although you won't find one on an iPad. This is a cheap way of boosting storage capacity.

04 Tablets rarely include a SIM card slot. This means you'll have to rely on Wi-Fi to get online, although some tablets let you access the internet through your smartphone. If you want mobile access to the internet, look for 3G- and 4G-ready devices. These almost always cost more than Wi-Fi-only models but they're great if you use your tablet while commuting or travelling.

05 Your choice of tablet determines the apps you can use on it. You may find that some of the apps you want are available on iOS but not Android and vice versa. Windows 10, meanwhile, runs traditional desktop applications.

TABLETS

SONY Xperia Z4 Tablet

★★★★★

£450 inc VAT • www.expansys.com



COMPUTER SHOPPER **RECOMMENDED** It's expensive, but the Z4 Tablet is a stunning bit of kit. It's lighter than the iPad Air 2, has a super-high-resolution screen with the most accurate colours we've seen from an LCD panel, runs Android 5 beautifully and has the longest battery life of any tablet we've tested.

PROCESSOR Octa-core 2GHz Qualcomm Snapdragon 810 • **SCREEN SIZE** 10.1in • **SCREEN RESOLUTION** 2,560x1,600 • **REAR CAMERA** 8.1 megapixels • **STORAGE** 32GB • **WIRELESS DATA** 4G (optional) • **DIMENSIONS** 167x254x6.1mm • **WEIGHT** 389g • **OPERATING SYSTEM** Android 5 • **WARRANTY** One year RTB • **DETAILS** www.sonymobile.com • **PART CODE** Xperia Z4 Tablet • **FULL REVIEW** Aug 2015

GOOGLE Nexus 9

★★★★★

£210 inc VAT • www.handtec.co.uk



COMPUTER SHOPPER **BEST BUY** The Nexus 9 is the first Google-branded tablet to have an iPad-style 4:3 ratio screen, which we think is a better shape for web browsing. Android 5.0 Lollipop runs beautifully and its battery life is superb.

PROCESSOR Dual-core 2.3GHz 64-bit Nvidia Tegra K1 Denver • **SCREEN SIZE** 8.9in • **SCREEN RESOLUTION** 2,048x1,536 • **REAR CAMERA** 8 megapixels • **STORAGE** 16GB • **WIRELESS DATA** 4G (optional) • **DIMENSIONS** 154x228x8mm • **WEIGHT** 425g • **OPERATING SYSTEM** Android 5.0 • **WARRANTY** One year RTB • **PART CODE** Nexus 9 • **DETAILS** www.google.com/nexus/9 • **FULL REVIEW** Feb 2015

APPLE iPad Air 2

★★★★★

£399 inc VAT • www.apple.com/uk



COMPUTER SHOPPER **BEST BUY** The iPad Air 2 is even thinner and lighter than its predecessor and still feels beautifully made. It's the fastest iPad yet, and now has TouchID fingerprint recognition for added security and more convenient unlocking.

PROCESSOR Tri-core 1.5GHz Apple A8X • **SCREEN SIZE** 9.7in • **SCREEN RESOLUTION** 2,048x1,536 • **REAR CAMERA** 8 megapixels • **STORAGE** 16GB • **WIRELESS DATA** 4G (optional) • **DIMENSIONS** 240x170x6.1mm • **WEIGHT** 437g • **OPERATING SYSTEM** iOS 9 • **WARRANTY** One year RTB • **PART CODE** Apple iPad Air 2 • **DETAILS** www.apple.com/uk • **FULL REVIEW** Feb 2015

MICROSOFT Surface 3

★★★★★

£499 inc VAT • www.currys.co.uk



COMPUTER SHOPPER **RECOMMENDED** If you're after a Windows tablet but the Surface Pro 4 is too much, the Surface 3 is the model to get. It's beautifully made with a great screen, and with the optional Type Cover keyboard it becomes a super-light laptop.

PROCESSOR Quad-core 1.6GHz Intel Atom X7-Z8700 • **SCREEN SIZE** 10.8in • **SCREEN RESOLUTION** 1,920x1,280 • **REAR CAMERA** 8 megapixels • **STORAGE** 128GB • **WIRELESS DATA** 4G (coming soon) • **DIMENSIONS** 187x267x8.7mm • **WEIGHT** 622g • **OPERATING SYSTEM** Windows 10 • **WARRANTY** One year RTB • **DETAILS** www.microsoft.com • **PART CODE** Surface 3 • **FULL REVIEW** Aug 2015

ASUS ZenPad S 8

★★★★★

£170 inc VAT • www.currys.co.uk



Cheap rarely means perfect, but the combination of high-resolution screen and low price makes the Asus ZenPad S 8 one of the better sub-£200 tablets on the market. It's beautifully styled, too, giving no indication it's a budget device.

PROCESSOR Quad-core 1.33GHz Intel Atom Z3560D • **SCREEN SIZE** 8in • **SCREEN RESOLUTION** 2,048x1,536 • **REAR CAMERA** 8 megapixels • **STORAGE** 16GB • **DIMENSIONS** 203x135x6.6mm • **WEIGHT** 317g • **OPERATING SYSTEM** Android 5.0 Lollipop • **WARRANTY** One year RTB • **DETAILS** www.asus.com/uk • **PART CODE** Z580C • **FULL REVIEW** Jan 2016

SAMSUNG Galaxy Tab S2 9.7

★★★★★

£400 inc VAT • www.currys.co.uk



COMPUTER SHOPPER **RECOMMENDED** Thanks to its amazing screen, strong performance and slimline chassis, the Galaxy Tab S2 9.7 is the most desirable Android tablet you can buy for around £350.

PROCESSOR Octa-core 1.9GHz + 1.3GHz Samsung Exynos Octa 5433 • **SCREEN SIZE** 9.7in • **SCREEN RESOLUTION** 2,048x1,536 • **REAR CAMERA** 8 megapixels • **STORAGE** 32GB • **WIRELESS DATA** 4G (+£90) • **DIMENSIONS** 169x5.6x237mm • **WEIGHT** 389g • **OPERATING SYSTEM** Android 5.0.2 • **WARRANTY** One year RTB • **DETAILS** www.samsung.com/uk • **PART CODE** SM-T810 • **FULL REVIEW** Dec 2015

Choosing a... Compact system camera

01 If you're ready to step beyond the basic controls of a compact camera, or you want greater flexibility than an ultra-zoom can offer, a compact system camera (CSC) is the next logical upgrade. With interchangeable lenses, manual controls and stellar image quality, these cameras give proper digital SLRs a run for their money.

02 There are three competing types of CSC mount, and the one you buy determines the number of compatible lenses and accessories you have available. Samsung's NX-mount is arguably the most limited in terms of lens selection, and the company has confirmed that it's shutting down its European camera business, so it's best to avoid these altogether if possible.

Sony's E-Mount has a slightly wider range, but Micro Four Thirds offers the widest variety. Both Panasonic and Olympus cameras use this mount, and the lenses are interchangeable between manufacturers.

03 Micro Four Thirds cameras are typically more compact than other types of CSC because the image sensor is physically smaller – with a 22mm diagonal, it's roughly 30% smaller than an APS-C sensor. The APS-C sensors that Sony and Samsung use in their CSCs are the same size as those in traditional digital SLRs.

04 Like digital SLRs, CSCs come at a wide range of prices. Available from as little as £200, there's a CSC to suit every

budget. Most come with at least one kit lens, but if you already have lenses for a particular CSC mount, you can buy the body on its own and save money.

05 Once you've settled on a particular mount, you should pay attention to a camera's features. Articulating screens and integrated viewfinders will help you compose shots, while extra physical controls and a hotshoe mount will give you flexibility for manual shooting.

Touchscreens are great, but they're no replacement for physical dials when it comes to changing shutter speed and aperture. An integrated flash is much more convenient than a detachable one, as you can never forget to take it with you.

PHOTOGRAPHY

PANASONIC Lumix DMC-G7

★★★★★

£539 inc VAT (with 14-42mm kit lens) • www.parkcameras.com

COMPUTER SHOPPER
BEST BUY

With sophisticated autofocus, superb controls and 4K video capture, the Panasonic G7 packs a serious punch for both video and stills.



SENSOR RESOLUTION 16 megapixels • **SENSOR SIZE** 17.3x13mm • **FOCAL LENGTH MULTIPLIER** 2x • **VIEWFINDER** Electronic (2,360,000 dots) • **LCD SCREEN** 3in (1,040,000 dots) • **OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS)** 3x (28-84mm) • **35mm-EQUIVALENT APERTURE** f/7-11.2 • **LENS MOUNT** Micro Four Thirds • **WEIGHT** 525g • **DIMENSIONS** 87x135x108mm • **WARRANTY** One year RTB • **DETAILS** www.panasonic.com/uk • **FULL REVIEW** Nov 2015

FUJIFILM X-T10

★★★★★

£569 inc VAT (with 16-50mm kit lens) • www.jessops.com

COMPUTER SHOPPER
BEST BUY

With superb controls, class-leading image quality and a low price, the X-T10 is an excellent CSC that rivals many enthusiast digital SLRs.



SENSOR RESOLUTION 16 megapixels • **SENSOR SIZE** 23.6x15.6mm (APS-C) • **FOCAL LENGTH MULTIPLIER** 1.5x • **VIEWFINDER** Electronic (2,360,000 dots) • **LCD SCREEN** 3in (920,000 dots) • **OPTICAL ZOOM (35mm-EQUIVALENT)** 3.1x (24-75mm) • **35mm-EQUIVALENT APERTURE** f/5.2-8.4 • **LENS MOUNT** Fujifilm X Mount • **WEIGHT** 576g (with 16-50mm lens) • **DIMENSIONS** 85x130x116mm • **WARRANTY** One year RTB • **DETAILS** www.fujifilm.eu/uk • **FULL REVIEW** Dec 2015

PANASONIC Lumix DMC-FZ330

★★★★★

£449 inc VAT • www.wexphotographic.com

COMPUTER SHOPPER
BEST BUY

A bridge camera with a huge 25-600mm zoom range that maintains a fast F2.8 aperture across the whole focal range.



SENSOR RESOLUTION 12 megapixels • **SENSOR SIZE** 1/2.3in • **VIEWFINDER** Electronic (1,440,000 dots) • **LCD SCREEN** 3in (1,040,000 dots) • **OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS)** 24x (25-600mm) • **35mm-EQUIVALENT APERTURE** f/15.6 • **WEIGHT** 703g • **DIMENSIONS** 93x133x122mm • **WARRANTY** One year RTB • **DETAILS** www.panasonic.com/uk • **FULL REVIEW** Jan 2016

CANON EOS 750D

★★★★★

£529 inc VAT (with 18-55mm kit lens) • www.currys.co.uk

COMPUTER SHOPPER
BEST BUY

The new mainstay of Canon's SLR line-up has better autofocus, D5500-beating image quality and decent video. It's the mid-range SLR to buy.



SENSOR RESOLUTION 24 megapixels • **SENSOR SIZE** 22.3x14.9mm (APS-C) • **FOCAL LENGTH MULTIPLIER** 1.6x • **VIEWFINDER** Optical • **LCD SCREEN** 3in • **OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS)** 3x (29-88mm) • **35mm-EQUIVALENT APERTURE** f/5.6-9 • **LENS MOUNT** Canon EF-S • **WEIGHT** 771g • **DIMENSIONS** 104x132x148mm • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **FULL REVIEW** Oct 2015

CANON PowerShot G7 X

★★★★★

£372 inc VAT • www.jessops.com

COMPUTER SHOPPER
BEST BUY

With near SLR-quality stills in a truly pocketable package, the PowerShot G7 X is a huge step up from most other compact cameras – and at an excellent price.



SENSOR RESOLUTION 20 megapixels • **SENSOR SIZE** 1in • **VIEWFINDER** None • **LCD SCREEN** 3in (1,040,000 dots) • **OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS)** 4.2x (24-100mm) • **35mm-EQUIVALENT APERTURE** f/4.9-7.6 • **WEIGHT** 301g • **DIMENSIONS** 64x107x40mm • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **FULL REVIEW** October 2015

NIKON D7200

★★★★★

£751 inc VAT (body only) • www.jessops.com

COMPUTER SHOPPER
BEST BUY

Best-in-class image quality and sublime ergonomics take the Nikon D7200 to the top of the pack for enthusiast DSLRs, whether you've already invested in the Nikon ecosystem or not.



SENSOR RESOLUTION 24 megapixels • **SENSOR SIZE** 23.5x15.6mm (APS-C) • **FOCAL LENGTH MULTIPLIER** 1.5x • **VIEWFINDER** Optical TTL • **LCD SCREEN** 3.2in (1,229,000 dots) • **LENS MOUNT** Nikon F Mount • **WEIGHT** 765g • **DIMENSIONS** 107x136x76mm • **WARRANTY** Two years RTB • **DETAILS** www.europe-nikon.com • **FULL REVIEW** Aug 2015

Choosing a... Display

01 A basic 24in LCD monitor costs around £100. It will be fine for typical Windows work but is likely to have poor viewing angles, so you'll need to sit straight on for the best picture quality. Its colour accuracy may not be very good, either.

02 A VGA input lets you use the monitor with any PC, but the quality may not be as good as it is over DVI or HDMI. Both are digital connections and require a compatible graphics card but they avoid the need for digital-to-analogue or analogue-to-digital conversions, which can reduce image quality. A digital connection achieves the best picture automatically, so you won't have to adjust clock or phase settings as you do with analogue connections.

Many DVI and all HDMI connections support HDCP, which lets you watch protected video content, such as Blu-ray movies. DisplayPort is becoming more popular, but you'll need a graphics card with a DisplayPort output (mini or full-size) to use this input on your monitor.

03 A larger monitor will be easier on the eye and may have a higher resolution. Most monitors have a resolution of at least 1,920x1,080 (1080p), which provides lots of room for working with multiple windows at the same time. For even higher resolutions, you'll need a larger display. Some 27in and 30in screens have 2,560x1,600 or even 4K resolutions. You'll need a graphics card with a dual-link DVI output and a dual-link DVI

cable or either HDMI or DisplayPort to use a monitor at these resolutions.

04 If you want better picture quality, look for a monitor with a high contrast ratio. The higher the ratio, the whiter the whites and the blacker the blacks. You'll also be able to see more fine detail in images with high contrast levels. Viewing angles are important, as wider angles mean you don't have to sit directly in front of the monitor to get the best picture. Wider viewing angles also allow more people to view the screen at the same time.

Fast response times reduce ghosting, but don't be dazzled by the numbers. A response time of 25ms or quicker is fine for all applications.

DISPLAYS

BENQ GW2765HT

★★★★★

£270 inc VAT • www.laptopsdirect.co.uk

COMPUTER SHOPPER
BEST BUY

This 27in 2,560x1,440 IPS monitor is one of the best-value screens we've ever seen. With near-perfect sRGB colour accuracy out of the box, it's a steal for less than £300.



SCREEN SIZE 27in • RESOLUTION 2,560x1,440 • SCREEN TECHNOLOGY IPS • VIDEO INPUTS VGA, DVI, HDMI, DisplayPort • WARRANTY Two years onsite • PART CODE 9H.LCELA.TBE • DETAILS www.benq.co.uk • FULL REVIEW Jan 2015

VIEWSONIC VX2363Smhl-W

★★★★★

£129 inc VAT • www.dabs.com

COMPUTER SHOPPER
RECOMMENDED

The 23in VX2363Smhl-W stands out from the crowd with its white stand, IPS screen and great overall image quality. It's a good budget buy for those who have modest needs.



SCREEN SIZE 23in • RESOLUTION 1,920x1,080 • SCREEN TECHNOLOGY IPS • VIDEO INPUTS VGA, HDMI, MHL-compatible HDMI • WARRANTY Two years collect and return • PART CODE VX2363Smhl-W • DETAILS www.viewsoniceurope.com • FULL REVIEW Jan 2015

IYYAMA ProLite GB2488HSU-B1

★★★★★

£200 inc VAT • www.box.co.uk

COMPUTER SHOPPER
BEST BUY

Gamers need look no further than the Iiyama ProLite GB2488HSU-B1. It's a no-nonsense Full HD panel with a 144Hz refresh rate for lightning-fast games performance.



SCREEN SIZE 24in • RESOLUTION 1,920x1,080 • SCREEN TECHNOLOGY TN • VIDEO INPUTS 2x HDMI, DVI, DisplayPort • WARRANTY Two years onsite • PART CODE ProLite GB2488HSU-B1 • DETAILS www.iiyama.com • FULL REVIEW Aug 2014

ASUS PB279Q

★★★★★

£570 inc VAT • www.laptopsdirect.co.uk

COMPUTER SHOPPER
BEST BUY

If you're remotely serious about design, photography or gaming and want an Ultra HD screen, this is the monitor to choose. It's plain to look at and has no USB hub, but in terms of pure image quality, nothing beats it at this price.



SCREEN SIZE 27in • RESOLUTION 3,840x2,160 • SCREEN TECHNOLOGY AHVA • REFRESH RATE 60Hz • VIDEO INPUTS 4x HDMI, DisplayPort, Mini DisplayPort • WARRANTY Three years RTB • DETAILS www.asus.com/uk • FULL REVIEW Apr 2015

SAMSUNG S32D850T

★★★★★

£405 inc VAT • www.laptopsdirect.co.uk

COMPUTER SHOPPER
BEST BUY

It's not cheap, but this 32in monitor is actually great value. Images are sharp and vibrant on its 2,560x1,440 panel, and the stand is among the most attractive we've seen.



SCREEN SIZE 32in • RESOLUTION 2,560x1,440 • SCREEN TECHNOLOGY VA • VIDEO INPUTS HDMI, DVI, DisplayPort • WARRANTY Two years collect and return • PART CODE S32D850T • DETAILS www.samsung.com/uk • FULL REVIEW Jan 2015

AOC U3477PQU

★★★★★

£500 inc VAT • www.currys.co.uk

COMPUTER SHOPPER
BEST BUY

Ultra-wide monitors are best suited to those who want to multitask on two full-size windows at once, but also kick back with a film or game in the evening. AOC's U3477PQU is the best example we've seen so far, with an incredible panel and excellent build quality.



SCREEN SIZE 34in • RESOLUTION 3,840x1,440 • SCREEN TECHNOLOGY IPS • REFRESH RATE 60Hz • VIDEO INPUTS DisplayPort, DVI, HDMI, VGA • WARRANTY Three years RTB • DETAILS www.aoc-europe.com • FULL REVIEW May 2015

Choosing a... TV

01 A 32in Full HD TV costs around £200 and will suit smaller living rooms. TVs look much smaller in the shop than in your home, so measure the space available before you buy.

Curved TVs are becoming increasingly more common, but bear in mind that these typically take up more floor space than a traditional flat set.

02 A 1,920x1,080-resolution TV can display a 1080p image. You can still buy TVs with a 720p (1,366x768) resolution, but they're no cheaper and the image won't be as sharp. 3,840x2,560 Ultra HD resolution, or 4K, TVs are finally available at reasonable prices, although you'll still pay a premium for one over a 1080p model.

03 Consider the number of inputs you'll need to connect the rest of your equipment. Two HDMI ports should be the bare minimum, but many TV sets come with four HDMI connectors. You'll need HDMI 2.0 if you want a future-proof 4K TV, as this is the only way to get 60fps video playback from external sources at such a high resolution.

If you want to plug a PC into your TV, you'll need to use either HDMI or VGA inputs. Be aware that some TVs only let you use a PC on an analogue input, and others won't display the Windows desktop at the TV's highest resolution.

04 The contrast ratio tells you the difference between the darkest

and the brightest shades that the screen will be able to display. The higher the number, the darker the blacks and the brighter the whites. A screen with a high contrast ratio is more likely to show a wider range of detail.

05 HD content is now becoming fairly widespread, but if you want Ultra HD content your options are more limited. Most Ultra HD TVs have Netflix built into their smart TV systems, but only BT is currently providing live Ultra HD video, with BT Sport Ultra HD.

Ultra HD Blu-ray players are due to arrive in 2016, but in the meantime Amazon's Fire TV set-top box will stream its Instant Video service at Ultra HD resolutions.

HOME CINEMA

PANASONIC TX-55CX700B

★★★★★

£899 inc VAT • www.currys.co.uk

COMPUTER SHOPPER
BEST BUY

Even before Currys slashed the price by £100, this was a great-value TV.

Outstanding 4K and Full HD image quality, a great smart TV operating system and a brilliant line-up of streaming and catch-up services make this TV a no-brainer.



SCREEN SIZE 55in • NATIVE RESOLUTION 3,840x2,160 • VIDEO INPUTS 3x HDMI (2x ARC), SCART, component, composite • TUNER Freeview HD • DIMENSIONS 762x1,237x242mm • WARRANTY One year RTB • DETAILS www.panasonic.com • PART CODE TX-55CX700B FULL REVIEW Jan 2016

SAMSUNG UE32J6300

★★★★★

£379 inc VAT • www.johnlewis.com

COMPUTER SHOPPER
RECOMMENDED

It might look expensive for the screen size, but the UE32J6300 is jam-packed with features, including one of the best smart TV systems around and every major UK catch-up TV service. It's the ideal small TV for a bedroom, kitchen or office.



SCREEN SIZE 32in • NATIVE RESOLUTION 1,920x1,080 • VIDEO INPUTS 4x HDMI, component, composite • TUNER Freeview HD • DIMENSIONS 428x370x91mm • WARRANTY One year RTB • DETAILS www.samsung.com/uk • PART CODE UE32J6300AK • FULL REVIEW Dec 2015

SAMSUNG BD-J7500

★★★★★

£119 inc VAT • www.cramptonandmoore.co.uk

COMPUTER SHOPPER
RECOMMENDED

4K upscaling, fantastic image quality and a wealth of

streaming service support makes the BD-J7500 so much more than just a Blu-ray player: it can turn any TV into a smart one, or replace a streaming media stick.



BLU-RAY PROFILE 5.0 • 3D CAPABLE Yes • DIMENSIONS 360x224x39mm • NETWORKING Ethernet, 802.11ac Wi-Fi • WARRANTY One year RTB • DETAILS www.samsung.com/uk • PART CODE BD-J7500 • FULL REVIEW Nov 2015

LG LHB725

★★★★★

£299 inc VAT • www.ao.com

COMPUTER SHOPPER
RECOMMENDED

A 3D-capable home-cinema surround system with a Blu-ray player that has fantastic image quality and speakers that deliver powerful sound, all housed in an attractive package.



HDMI INPUTS/OUTPUTS 2/1 • HDMI 2.0 INPUTS/OUTPUTS 2/1 • OUTPUT RESOLUTIONS 720p, 1080p • WIRELESS SUPPORT 802.11n, Bluetooth • SPEAKER CONFIGURATION 5.1 • RMS POWER OUTPUT TOTAL 1,200W • DIMENSIONS 410x55x260mm • WARRANTY One year RTB • DETAILS www.lg.com/uk • PART CODE LHB725 • FULL REVIEW Oct 2015

SAMSUNG HW-J7500

★★★★★

£469 inc VAT • www.hificonfidential.co.uk

COMPUTER SHOPPER
RECOMMENDED

This curved 8.1 soundbar with wireless subwoofer not only looks great, but

also produces excellent sound and has plenty of ports. If you have a curved TV this is the soundbar to pair it with.



SPEAKERS 8 • RMS POWER OUTPUT 320W • DOCK CONNECTOR None • NETWORKING Bluetooth 3.0 • DIMENSIONS 1,230x170x42mm (soundbar), 291x371x291mm (subwoofer) • WEIGHT 4kg (soundbar), 7.8kg (subwoofer) • WARRANTY One year RTB • DETAILS www.samsung.com/uk • PART CODE HW-J7500 • FULL REVIEW Jul 2015

PHILIPS Fidelio XS1 SoundStage

★★★★★

£404 inc VAT • www.amazon.co.uk

COMPUTER SHOPPER
BEST BUY

The Fidelio XS1 SoundStage is a beautiful-looking soundbase with sound

quality that matches its stunning design. There are plenty of connections, including Bluetooth, and the wireless subwoofer delivers the lower frequencies with aplomb.



SPEAKERS 3 • RMS POWER OUTPUT 60W • DIMENSIONS 730x331x40mm • WEIGHT 5.3kg • DOCK CONNECTOR None • NETWORKING Bluetooth (SBC, aptX, AAC) • WARRANTY One year RTB • DETAILS www.philips.co.uk • PART CODE Fidelio XS1/12 • FULL REVIEW Jan 2016

Choosing a... Soundbar

01 If you don't have space in your home cinema setup for a set of surround-sound speakers, a soundbar is the next best thing. Whether you opt for a soundbar (which typically sits in front of your TV stand) or a soundplate (which sits underneath your TV), you'll be getting significantly better audio than the weedy speakers today's flatscreen TVs provide.

02 If you want to cut down on cable clutter, look for a soundbar with multiple HDMI inputs and outputs as well as Audio Return Channel (ARC). Not all soundbars use HDMI, with many making do with digital optical audio connections instead. This means you'll have to connect Blu-ray players, games consoles and set-top

boxes to your TV and run all audio through a single cable. Also look for phono inputs for connecting older devices and 3.5mm audio jacks for tablets or smartphones.

03 As with any speaker, the number of speaker drivers inside a soundbar should give a good indication of its audio capabilities. Although this won't tell you everything about sound quality, you should still look out for separate mid-range drivers and tweeters, as these should be able to deliver a wider frequency range than full-range drivers alone.

04 Bluetooth support is a must if you want to listen to music from a smartphone or tablet without wires.

Most soundbars now include Bluetooth as standard but, if your device supports it, it's worth looking for a mobile soundbar that includes aptX. This less-lossy codec is capable of higher-quality streaming than the standard A2DP profile.

AirPlay streaming is less common, but iPhone owners should keep an eye out for it.

05 For a little extra bass, be sure to look for a soundbar with a separate subwoofer. Many soundbars include a wired sub, but for extra convenience you should look for a model with a wireless subwoofer instead. These can be placed anywhere in a room near a power socket, without having to run a cable back to the soundbar itself.

AUDIO

PHILIPS Fidelio M2BT

★★★★★

£200 inc VAT • www.currys.co.uk

COMPUTER SHOPPER
BEST BUY

The Philips Fidelio M2BT are premium Bluetooth headphones that sound great, look fantastic and are supremely comfortable to wear. Battery life is pretty reasonable, too, at around 10 hours.



HEADPHONES SUBTYPE On-ear Bluetooth • **PLUG TYPE** 3.5mm jack plug • **WEIGHT** 190g • **CABLE LENGTH** 1.2m • **WARRANTY** One year RTB • **DETAILS** www.philips.co.uk • **PART CODE** Philips Fidelio M2BTBK • **FULL REVIEW** Apr 2015

RAUMFELD One S

★★★★★

£200 inc VAT • www.raumfeld.com/uk

COMPUTER SHOPPER
RECOMMENDED

The One S is a great compact speaker that sounds great solo or even better as a stereo pair, and it has a classy design that matches its refined sound.



SPEAKERS 2 • **RMS POWER OUTPUT** 30W • **DOCK CONNECTOR** None • **NETWORKING** 802.11n Wi-Fi, Ethernet • **DIMENSIONS** 180x110x130mm • **WEIGHT** 1.4kg • **STREAMING FORMATS** UPnP, Mesh Network • **WARRANTY** One year RTB • **DETAILS** www.raumfeld.com/uk • **PART CODE** One S • **FULL REVIEW** Nov 2015

RAZER Leviathan

★★★★☆

£150 inc VAT • www.box.co.uk

COMPUTER SHOPPER
RECOMMENDED

Soundbars are usually built for TVs, but Razer's

Leviathan is ideal for sliding underneath a computer monitor. It sounds great and is more than loud enough to fill a room. It also has built-in Bluetooth streaming.



SPEAKERS 4 • **RMS POWER OUTPUT** 30W • **WEIGHT** 2kg (bar), 2.3kg (subwoofer) • **NETWORKING** Bluetooth (SBC, aptX) • **WARRANTY** Two years RTB • **DETAILS** www.razerzone.com • **PART CODE** RZ05-01260100-R3G1 • **FULL REVIEW** Jul 2015

ULTIMATE EARS UE Megaboom

★★★★☆

£230 inc VAT • www.ballicom.co.uk

COMPUTER SHOPPER
RECOMMENDED

The Ultimate Ears UE Megaboom is an intensely loud and powerful Bluetooth speaker that provides a warm and impactful sound. It's waterproof, too, so could provide some entertainment by the poolside or at your next barbecue.



SPEAKERS 4 • **RMS POWER OUTPUT** Not disclosed • **DOCK CONNECTOR** None • **WIRELESS** Bluetooth (SBC) • **DIMENSIONS** 83x83x226mm • **WEIGHT** 877g • **WARRANTY** Two years RTB • **DETAILS** www.ultimateears.com • **PART CODE** UE Megaboom • **FULL REVIEW** Aug 2015

ARCAM miniBlink

★★★★★

£100 inc VAT • www.petertyson.co.uk

COMPUTER SHOPPER
RECOMMENDED

While slightly more expensive than some rival devices, the miniBlink Bluetooth adaptor makes up for it with high-quality components and an attractive design. The miniBlink makes for a great match even for high-end audio systems if you want to add wire-free Bluetooth streaming.



WARRANTY Two years RTB • **DETAILS** www.arcam.co.uk • **PART CODE** miniBlink • **FULL REVIEW** Aug 2014

SONOS Play:5

★★★★★

£429 inc VAT • www.johnlewis.com

COMPUTER SHOPPER
RECOMMENDED

The Play:5 improves on the original with a more attractive design and better acoustics. It delivers room-filling sound with fantastic detail, and Sonos's music-streaming compatibility is second to none.



SPEAKERS 6 • **RMS POWER OUTPUT** Not disclosed • **DOCK CONNECTOR** None • **NETWORKING** 802.11bg Wi-Fi, Ethernet • **DIMENSIONS** 364x154x203mm • **WEIGHT** 6.36kg • **STREAMING FORMATS** SonosNet • **WARRANTY** One year RTB • **DETAILS** www.sonos.com • **PART CODE** Play:5 • **FULL REVIEW** Feb 2016

Choosing a... Media streamer

01 Media streamers have come a long way from the hard disk-based set-top boxes of a few years ago. They now come in two main forms: flash drive-sized dongles that plug directly into the HDMI port in the back of your TV, and larger microconsoles that sit under it. Whichever model you choose, it will stream content from the internet rather than storing media files locally.

02 Most streamers use their own operating system, which you can navigate with a bundled remote control, but Google's Chromecast dongle requires a paired smartphone, tablet or laptop to stream content on the big screen. If you're looking to set up Netflix for someone who

doesn't have a smartphone, you should buy a standalone streamer such as a Roku or Amazon Fire TV device.

03 A media streamer is only as good as the services it supports, although a device that offers more services won't necessarily offer more high-quality content than a media streamer with fewer channels. Instead, look out for major channels such as Netflix, Amazon Instant Video, BBC iPlayer, Sky Go and YouTube. If any of these are missing, the remaining channels aren't likely to be much cop.

04 Although nearly all streamers now pull content from the web, they're still capable of playing content stored locally

from a networked PC or NAS device. Not all streamers are capable of playing all media file formats, however. If you have a lot of MKV or MOV files, check that your chosen streamer supports them before you buy. These are typically the file formats devices struggle with the most.

05 Media streamers aren't just for video, either. Many support online music services including Spotify, Rdio and TuneIn Radio. Others essentially use the same hardware as a smartphone and are capable of running apps or playing games. Some of the most powerful are compatible with dedicated game controllers, but these are typically sold as optional accessories rather than bundled with the streamer.

VIDEO

AMAZON Fire TV Stick

★★★★★

£35 inc VAT • www.amazon.co.uk

COMPUTER SHOPPER
RECOMMENDED

This bargain media-streaming device excels for Amazon Prime subscribers.

Even if you're not, you'll get good mileage out of it with platforms such as Plex. It's our favourite discrete streaming device.



VIDEO OUTPUTS HDMI 1.4 • **NETWORKING** 802.11n • **DIMENSIONS** 115x115x17mm • **STREAMING FORMATS** UPnP, AirPlay, DLNA • **INTERNET STREAMING SERVICES** iPlayer, Netflix, Sky News, Spotify, TuneIn Radio, Amazon Instant Video, TVPlayer • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Fire TV Stick • **FULL REVIEW** Aug 2015

GOPRO Hero4 Black

★★★★★

£310 inc VAT • www.amazon.co.uk

COMPUTER SHOPPER
RECOMMENDED

The GoPro Hero4 Black doesn't deviate from the existing GoPro template but it's an excellent action camera that introduces stunning 4K video at 30fps. You also get support for a wide range of mounts and accessories.



SENSOR 1/2.3in CMOS • **SENSOR PIXELS** 12,000,000 • **MAX RECORDING RESOLUTION** 4K (30fps) • **AV CONNECTIONS** Micro HDMI output, 3.5mm microphone to Mini USB (optional) • **DIMENSIONS** 41x59x30mm • **WEIGHT** 89g (152g with housing) • **WARRANTY** One year RTB • **PART CODE** CHDHX-4-1-EU • **DETAILS** www.gopro.com • **FULL REVIEW** May 2015

HUMAX HDR-1100S 500GB

★★★★★

£190 inc VAT • www.johnlewis.com

COMPUTER SHOPPER
BEST BUY

The Humax HDR-1100S is an attractive

Freesat+ PVR that's easy to use and integrates catch-up TV seamlessly through Freetime.



TUNERS 2x DVB-S2 Freesat • **DIMENSIONS** 280x48x200mm • **NETWORKING** Gigabit Ethernet, 802.11n Wi-Fi • **INTERNAL DISK CAPACITY** 500GB • **WARRANTY** One year RTB • **DETAILS** www.humaxdirect.co.uk • **PART CODE** HDR-1100S-White • **FULL REVIEW** Dec 2015

VEHO Muvi K2 NPNG

★★★★★

£218 inc VAT • www.amazon.co.uk

COMPUTER SHOPPER
RECOMMENDED

The K2 packs in plenty of action camera features for a budget price, and

comes with a generous number of accessories, including a useful hard transport case. Image quality is very respectable, too.



SENSOR PIXELS 16,000,000 • **MAX RECORDING RESOLUTION** 1080p (60fps) • **AV CONNECTIONS** Mini HDMI • **DIMENSIONS** 40x23x60mm • **WEIGHT** 84g • **WARRANTY** One year RTB • **DETAILS** www.veho-muvi.com • **PART CODE** K2NPNG • **FULL REVIEW** Dec 2015

PANASONIC HC-WX970

★★★★★

£612 inc VAT • www.photospecialist.co.uk

COMPUTER SHOPPER
RECOMMENDED

This twin-camera 4K-capable camcorder lets you capture 8-megapixel stills from 4K video. It has superb image stabilisation and its HDR video mode can help with exposing difficult scenes.



OPTICAL ZOOM 20x • **SENSOR** 1/2.3in BSI MOS • **LCD SCREEN** 3in, 460,800 dots • **DIMENSIONS** 73x65x139mm • **WEIGHT** 360g • **WARRANTY** One year RTB • **DETAILS** www.panasonic.co.uk • **PART CODE** HC-WX970 • **FULL REVIEW** Sep 2015

HAUPPAUGE HD PVR Rocket

★★★★★

£85 inc VAT • www.maplin.co.uk

COMPUTER SHOPPER
RECOMMENDED

The HD PVR Rocket lets you record your gameplay whether you're playing on a PC or games console, and you can even record your own commentary as you play thanks to its built-in microphone input. It's well designed, with a large, red Record button and the ability to record directly to a USB drive.



WARRANTY Two years RTB • **DETAILS** www.hauppauge.co.uk • **PART CODE** 1527 • **FULL REVIEW** Apr 2013

Choosing a... Laser printer

01 Laser printers used to be much more expensive than inkjets and were typically restricted to offices. They are now much more affordable, however, and offer several benefits over inkjets, including lower per-page printing costs and faster print speeds.

02 A decent laser printer will typically cost around £80, and will happily print hundreds of black-and-white pages per hour. If documents are your priority, you'll want a high minimum speed and low print costs. However, you'll probably be limited to black-and-white printing at this price.

03 Although you can still buy single-function laser printers, multifunction

peripherals (MFPs) are now far more common. These models can scan and photocopy documents as well as print them, and some of them also have fax capabilities. Laser MFPs start from around £200.

04 Heavy-duty office lasers designed for printing thousands of pages per month can cost thousands of pounds. They use large individual toner drums, which can cut running costs. Automatic duplex (double-sided) printing is also common here.

05 Although laser printers are more suited to printing text than graphics, many are still able to produce high-quality photographs. Speed isn't a priority here – instead choose a printer that reproduces

subtle tones well. You can't determine this by looking at the specifications; only hands-on testing will do, so remember to check our reviews before you buy. Borderless printing (up to the edge of the paper) should also be possible.

06 If you want to print from multiple devices, make sure you look for extended connectivity. Decent laser printers can be shared on your local network and have USB ports for direct printing, memory card slots for printing images from a digital camera, and iOS, Android or Google Cloud Print support for printing from mobile devices such as smartphones or tablets. An LCD preview screen offers greater control for this method of printing.

PRINTERS & SCANNERS

RICOH SP 3600DN

★★★★★

£160 inc VAT • www.ebuyer.com

COMPUTER SHOPPER
BUSINESS BUY

The SP 3600DN can print up to 50,000 pages per month at 30ppm.

The quality is good, and each page costs only about 1.2p. It's a good choice for a busy small firm.



TECHNOLOGY Mono LED • MAXIMUM PRINT RESOLUTION 1,200x1,200dpi • DIMENSIONS 268x370x392mm • WEIGHT 14.5kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY Two years RTB • DETAILS www.ricoh.co.uk • PART CODE 906231 • FULL REVIEW Oct 2015

CANON i-SENSYS LBP7780Cx

★★★★★

£414 inc VAT • www.printerland.co.uk

COMPUTER SHOPPER
BEST BUY

It's somewhat expensive to buy, but the Canon i-SENSYS LBP7780Cx is very cheap to run, and produces impressively high-quality prints.



TECHNOLOGY Single-pass colour laser • MAXIMUM PRINT RESOLUTION 600x600dpi • DIMENSIONS 401x517x530mm • WEIGHT 31kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year onsite • DETAILS www.canon.co.uk • PART CODE 6140B010AA • FULL REVIEW Mar 2015

EPSON Expression Photo XP-760

★★★★★

£125 inc VAT • www.ebuyer.com

COMPUTER SHOPPER
BEST BUY

It's not brilliant for printing office documents, but if you want great photos and brilliant scanning, Epson's good-looking and compact XP-760 is perfect.



TECHNOLOGY Piezo inkjet • MAXIMUM PRINT RESOLUTION 5,760x1,440dpi • SCANNER RESOLUTION 2,400x4,800dpi • DIMENSIONS 148x455x369mm • WEIGHT 6.9kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year RTB • DETAILS www.epson.co.uk • PART CODE C11CD96401 • FULL REVIEW Mar 2015

CANON Pixma MG6650

★★★★★

£88 inc VAT • www.viking-direct.co.uk

COMPUTER SHOPPER
BEST BUY

This well-specified MFP isn't the fastest, but its print, copy and scan quality are superb. Improved touchscreen controls make it easier to use than some Pixmas, and its ink costs are reasonable too.



TECHNOLOGY Thermal inkjet • MAXIMUM PRINT RESOLUTION 4,800x1,200dpi • SCANNER RESOLUTION 1,200x2,400dpi • DIMENSIONS 148x455x369mm • WEIGHT 6.4kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year RTB • DETAILS www.canon.co.uk • PART CODE 9539B008AA • FULL REVIEW Aug 2015

HP Officejet Pro X476dw

★★★★★

£316 inc VAT • www.printerland.co.uk

COMPUTER SHOPPER
BEST BUY

It may be an inkjet, but HP's MFP beats many colour lasers in terms of speed, print quality and running costs. It's ideal for homes and small offices alike.



TECHNOLOGY Thermal inkjet • MAXIMUM PRINT RESOLUTION 2,400x1,200dpi • SCANNER RESOLUTION 1,200x1,200dpi • DIMENSIONS 517x517x399mm • WEIGHT 24kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year onsite • DETAILS www.hp.co.uk • PART CODE CN461A • FULL REVIEW March 2015

PLUSTEK eScan A150

★★★★★

£385 inc VAT • www.ebuyer.com

COMPUTER SHOPPER
RECOMMENDED

A very easy-to-use document scanner that can scan both sides of a document at once, and lets you organise your scans onscreen before saving them to a computer, USB disk or Android device.



SCANNER TYPE Document scanner • MAXIMUM OPTICAL SCAN RESOLUTION 600x600dpi • DIMENSIONS 189x318x170mm • WEIGHT 2.8kg • WARRANTY One year RTB • DETAILS www.plustek.com/uk • PART CODE 0263UK • FULL REVIEW Feb 2016

Choosing a... NAS device

01 A network-attached storage (NAS) device lets you store documents, media, and other files on its hard disks so you can share them with other devices on your network. Some have disks already installed, while others are empty enclosures into which you install your own disks. Buying an empty NAS can often be the more cost-effective option, as they're usually less expensive and give you the freedom to expand the number of disks at a later date.

You should buy one with a Gigabit Ethernet interface, as these provide the highest transfer speeds. To use a NAS device at these speeds, you'll need computers with Gigabit Ethernet network adaptors and a Gigabit Ethernet switch or router. Computers with Fast Ethernet adaptors

can still access the NAS device, but only at the much slower speed of 100Mbit/s.

02 The amount of network storage you need depends on the types of files you use. If you want to store Word and Excel documents, for example, a 1TB device will be fine. In fact, a 1TB device should be sufficient for a family's entire media collection, regardless of how many music and video files everyone owns. Small businesses should consider higher storage capacities, depending on the nature of the business.

03 If you can see no end to your storage needs, you should buy an upgradable NAS device. Many have a USB port for adding an external disk. Devices such as

Synology's barebones NAS kits have spare disk trays for cheaper and faster upgrades.

04 If you want extra protection for your data, look for a device that supports RAID. RAID 1 and RAID 5 arrays reduce the available capacity by duplicating data, but you won't lose it if a disk fails.

05 If you need access to your files while you're away, look for a NAS device with an FTP server. Some can also share a USB printer across your network.

A NAS device with a Universal Plug and Play (UPnP) or DLNA media server can stream your music, photos and videos to a network media player, so you can enjoy your media collection in another room.

NETWORKS

TP-LINK Archer C9

★★★★★

£90 inc VAT • www.currys.co.uk

COMPUTER SHOPPER
BEST BUY

It doesn't have a modem, so you'll need to pair it with your ISP's cable, ADSL or fibre modem, but the Archer C9 is an incredibly capable router with plenty of features and fantastic wireless performance, at a very reasonable price.



MODEM None • WI-FI STANDARD 802.11ac • STATED SPEED 1,900Mbit/s • USB PORTS 1x USB3, 1x USB2 • WALL MOUNTABLE No • WARRANTY Three years RTB • DETAILS uk.tp-link.com • PART CODE Archer C9 • FULL REVIEW Sep 2015

BT Dual-Band Wi-Fi Extender 1200

★★★★★

£50 inc VAT • www.currys.co.uk

COMPUTER SHOPPER
RECOMMENDED

This fast wireless extender is very easy to set up and is the perfect companion to an 802.11ac router. The wired LAN port lets you connect a wired device to your wireless network, too.



WI-FI STANDARD 802.11ac • STATED SPEED 867Mbit/s • LAN PORTS 1 • WARRANTY Three years RTB • DETAILS www.shop.bt.com • PART CODE 80462 • FULL REVIEW Aug 2015

DEVELO dLAN 1200+ Starter Kit

★★★★★

£110 inc VAT • www.scan.co.uk

COMPUTER SHOPPER
RECOMMENDED

The fastest Powerline networking kit we've seen, and even though you're limited to a single Gigabit Ethernet connection, it's the ideal way to network a single computer. The passthrough sockets are very convenient, too.



POWERLINE NETWORKING STANDARD HomePlug • STATED SPEED 1,200Mbit/s • ADAPTORS IN BOX 2 • WARRANTY Three years RTB • DETAILS www.develo.com/uk • PART CODE 09378 • FULL REVIEW Feb 2015

ASUS EA-AC87

★★★★★

£114 inc VAT • www.box.co.uk

COMPUTER SHOPPER
RECOMMENDED

It's much larger than the average range extender, but that's only to make room for a whopping five Gigabit Ethernet ports. The EA-AC87 can also act as an access point, replacing your router.



MODEM None • WI-FI STANDARD 802.11ac • STATED SPEED 1,734Mbit/s • USB PORTS 0 • WALL MOUNTABLE Yes • WARRANTY Two years RTB • DETAILS www.asus.com/uk • PART CODE 90IG01A0-BU9000 • FULL REVIEW Sep 2015

CANARY All-In-One Security

★★★★★

£160 inc VAT • www.currys.co.uk

It's expensive, but the Canary is a great one-box, cloud-based home security camera that's easy to use and produces high-quality footage.



SENSOR Not disclosed • VIEWING ANGLE 147° wide angle • VIDEO RECORDING FRAME RATES 1080p (30fps) • NIGHT VISION MODE Infrared LEDs • DIMENSIONS 152x76x76mm • WEIGHT 400g • WARRANTY One year RTB • DETAILS canary.is • PART CODE CT100UKWT • FULL REVIEW Mar 2016

NETGEAR Arlo

★★★★★

£280 inc VAT • www.currys.co.uk

COMPUTER SHOPPER
RECOMMENDED

Incredibly flexible camera placement and great image quality make Netgear's Arlo a fantastic home security system, even if the base station is a tad expensive.



SENSOR CMOS (size not stated) • VIEWING ANGLE Horizontal 130° • VIDEO RECORDING (FRAME RATES) 720p (24fps) • NIGHT VISION MODE Infrared LEDs • DIMENSIONS 71x40x63mm • WEIGHT 110g • WARRANTY One year RTB • DETAILS www.arlo.com/uk • PART CODE 131178 • FULL REVIEW Sep 2015

Choosing an... Internal hard disk

01 A basic 1TB internal hard disk should cost around £40. This will be fast enough for general use and will provide enough storage for most users.

Make sure the hard disk you choose has the appropriate interface type for your PC. Some mechanical hard disks still come with SATA2 interfaces, but newer models and most solid-state drives (SSDs) have faster SATA3 interfaces. You'll need a motherboard with a SATA3 port if you want to benefit from SATA3's faster speeds; SATA3 disks will work with SATA2 ports but can only transfer files at SATA2 speeds.

02 SSDs can make the most of SATA3's extra bandwidth for fast file transfers. They use flash memory similar to that found

in USB flash drives, and although they tend to provide less capacity than mechanical hard disks, they're significantly faster.

03 Buy a hard disk that provides more capacity than you think you need, as your storage requirements are likely to grow. A 3TB disk strikes the best balance between capacity and low cost per gigabyte, but in general you should aim to buy the largest disk you can afford.

04 If you want more disk space or you want to protect your data against disk failure, think about buying several hard disks to create a RAID array. These use multiple hard disks to create one large logical disk with better performance, or to

duplicate your data for better protection. RAID arrays require hard disks of the same size. In theory, they can be from different manufacturers, but it's better to buy identical disks if you can.

05 A hard disk's spindle speed determines how quickly it can transfer data. A spindle speed of 7,200rpm is common in desktop drives and is fast enough for most purposes. Desktop hard disks with 5,400rpm spindle speeds are quite slow but use less power and generate less heat and noise.

To strike the best balance between speed and storage capacity, use an SSD as your system disk and store your files on a larger mechanical disk.

STORAGE

SAMSUNG 850 Evo 500GB

★★★★★

£132 inc VAT • www.scan.co.uk

COMPUTER SHOPPER Samsung's 850 Evo is simply the fastest SATA SSD around, and it's available in a wide range of capacities. The 2TB model might be expensive at around £527 (from www.scan.co.uk), but it means saying goodbye to mechanical storage for good.



CAPACITY 500GB • COST PER GIGABYTE £0.26 • INTERFACE SATA3 • CLAIMED READ 540MB/s • CLAIMED WRITE 520MB/s • WARRANTY Five years RTB • DETAILS www.samsung.com/uk • PART CODE MZ-75E500BW/EU • FULL REVIEW Oct 2015

WESTERN DIGITAL Red 6TB

★★★★★

£200 inc VAT • www.dabs.com

COMPUTER SHOPPER The Red 6TB combines excellent performance with a high capacity and special firmware to make a hard disk that's perfect for use in NAS enclosures. It's guaranteed for three years, too, which should provide peace of mind.



CAPACITY 6TB • PRICE PER GIGABYTE £0.03 • INTERFACE SATA3 • WARRANTY Three years RTB • DETAILS www.wdc.com • PART CODE WD60EFRX • FULL REVIEW Nov 2014

SYNOLOGY DiskStation DS215J

★★★★★

£130 inc VAT • www.ebuyer.com

COMPUTER SHOPPER Synology's latest NAS is faster than its predecessor thanks to an upgraded CPU, and is capable of rapid file transfers. DSM is still the best NAS operating system we've used, too.



3½in HARD DISK BAYS (FREE) 2 (2) • NETWORKING 2x 10/100/1,000 Ethernet • DLNA MEDIA SERVER Yes • PRINT SERVER Yes • DIMENSIONS 165x100x226mm • WEIGHT 870g • WARRANTY Two years RTB • DETAILS www.synology.com • PART CODE DS215J • FULL REVIEW Jun 2015

SAMSUNG T1 500GB

★★★★★

£169 inc VAT • www.ebuyer.com

COMPUTER SHOPPER The T1 is significantly faster than any USB3 flash drive as it has its own SD controller. Combined with a USB3 connection, it's able to transfer files at unbelievable speeds, then slips into a pocket for taking on the move.



CAPACITY 500GB • COST PER GIGABYTE £0.34 • INTERFACE USB3 • CLAIMED READ 450MB/s • CLAIMED WRITE 450MB/s • WARRANTY Three years RTB • DETAILS www.samsung.com/uk • PART CODE MU-PS500B/EU • FULL REVIEW Apr 2015

TOSHIBA Canvio Connect II 2TB

★★★★★

£74 inc VAT • www.dabs.com

COMPUTER SHOPPER There's plenty of choice when it comes to portable hard disks, but Toshiba's Canvio Connect II has an excellent bundled software package and impressive USB3 speeds. Considering the price, there's no reason not to have one.



CAPACITY 2TB • COST PER GIGABYTE £0.04 • INTERFACE USB3 • WARRANTY One year RTB • DETAILS www.toshiba.eu • PART CODE HDTCC820ER3CA • FULL REVIEW Nov 2015

SAMSUNG 950 Pro 256GB

★★★★★

£146 inc VAT • www.ebuyer.com

COMPUTER SHOPPER A true sign of things to come for storage: it's the fastest, most affordable NVMe SSD yet. If your motherboard is compatible with PCI Express storage, you absolutely need one.



CAPACITY 256GB • COST PER GIGABYTE £0.57 • INTERFACE M.2 (2280)/NVMe • CLAIMED READ 2,200MB/s • CLAIMED WRITE 900MB/s • WARRANTY Five years RTB • DETAILS www.samsung.com/uk • PART CODE MZ-V5P256BW • FULL REVIEW Jan 2016



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AT AMAZON.CO.UK



SOFTWARE

XARA Web Designer 11 Premium

★★★★★

£70 inc VAT • www.xara.com/uk

Web
design

**COMPUTER
SHOPPER**
BEST BUY

Web Designer was already excellent, but version 11 gets a slew of incremental updates that ensure it remains our favourite one-box web design tool.

OS SUPPORT Windows XP or later • MINIMUM Intel Celeron/AMD Sempron • MINIMUM GPU DirectX 9 • MINIMUM RAM 500MB • HARD DISK SPACE 300MB • DETAILS www.xara.com/uk • FULL REVIEW Sep 2015

ADOBE Premiere Elements 14

★★★★★

£65 inc VAT • www.wexphotographic.com

Video
editing

**COMPUTER
SHOPPER**
BEST BUY

Lots of features to keep advanced users happy and even more to help new users make the most of it. It's the consumer video editing package to buy.

OS SUPPORT Windows 7/8/10 • MINIMUM CPU 2GHz with SSE2 • MINIMUM GPU DirectX 9 • MINIMUM RAM 2GB • HARD DISK SPACE 5GB • DETAILS www.adobe.com/uk • PRODUCT CODE 65234288 • FULL REVIEW Jan 2016

ADOBE Photoshop Lightroom 6

★★★★★

£90 inc VAT • www.ebuyer.com

Photo
editing

**COMPUTER
SHOPPER**
BEST BUY

Lightroom 6 might be a relatively modest update, but Adobe's photography toolbox still sets the gold standard for Raw photo processing and image enhancement.

OS SUPPORT Windows 7/8 • MINIMUM CPU Intel or AMD with 64-bit support • MINIMUM GPU 1GB, OpenGL 3.3, DirectX 10 • MINIMUM RAM 2GB • HARD DISK SPACE 2GB • DETAILS www.adobe.com/uk • PRODUCT CODE 65237576 • FULL REVIEW Feb 2015

SERIF Affinity Designer

★★★★★

£40 inc VAT • www.apple.com/itunes

Graphic
design

**COMPUTER
SHOPPER**
BEST BUY

The first real competition to Adobe's Illustrator might be an OS X exclusive, but Affinity Designer is a seriously powerful graphic design tool that costs an incredible £40.

OS SUPPORT Apple OS X 10.7.5 • MINIMUM CPU Core 2 Duo (64-bit) • MINIMUM GPU Intel HD Graphics • MINIMUM RAM 1GB • HARD DISK SPACE 325GB • DETAILS affinity.serif.com • PRODUCT CODE Affinity Designer • FULL REVIEW Mar 2015

STEINBERG Cubase Artist 8

★★★★★

£221 inc VAT • www.steinberg.net

Music
production

**COMPUTER
SHOPPER**
BEST BUY

Music production software usually saves the best features for the priciest version, but that's not the case here, making Cubase Artist 8 an excellent investment for musicians aspiring to the highest standards.

OS SUPPORT Windows 7 or later • MINIMUM CPU Intel Core/AMD dual-core • MINIMUM GPU DirectX 10 • MINIMUM RAM 4GB • HARD DISK SPACE 15GB • DETAILS www.steinberg.net • PRODUCT CODE 45550 • FULL REVIEW May 2015

XARA Photo & Graphic Designer 11

★★★★★

£50 inc VAT • www.xara.com/uk

Image
editing

**COMPUTER
SHOPPER**
BEST BUY

Powerful new warping and brush tools take Photo & Graphic Designer to new heights, making it a genuine rival to Adobe's Photoshop and Lightroom. It's cheaper, too.

OS SUPPORT Windows 7/8/8.1/10 • MINIMUM CPU Celeron, Sempron or newer • MINIMUM GPU N/A • MINIMUM RAM 500MB • HARD DISK SPACE 300MB • DETAILS www.xara.com/uk • FULL REVIEW Dec 2015

GAMES

Fallout 4

★★★★★

£40 inc VAT • store.steampowered.com

Open-world
adventure

**COMPUTER
SHOPPER**
BEST BUY

Exploring a post-apocalyptic wasteland has never been more fun. Bethesda has expanded the Fallout universe with base building and crafting mechanics, making this the definitive entry in the series.

AVAILABLE FORMATS PC, Xbox One, PS4 • OS SUPPORT Windows 7/8.1/10 64-bit • MINIMUM CPU Quad-core 2.8GHz Intel, quad-core 3GHz AMD • MINIMUM GPU Nvidia GeForce GTX 550 Ti, AMD Radeon HD 7870 • MINIMUM RAM 8GB • HARD DISK SPACE 30GB • DETAILS www.fallout4.com • FULL REVIEW Feb 2016

Metal Gear Solid V: The Phantom Pain

★★★★★

£46 inc VAT • store.steampowered.com

Stealth
action

**COMPUTER
SHOPPER**
BEST BUY

Whether the story was ever really finished before director Hideo Kojima's infamous departure or not remains a mystery, but the Phantom Pain's open-world stealth gameplay is simply without fault.

AVAILABLE FORMATS PC, Xbox 360, Xbox One, PlayStation 3, PS4 • OS SUPPORT Windows 7/8.1 64-bit • MINIMUM CPU Dual-core 3.4GHz Intel, quad-core AMD • MINIMUM GPU Nvidia GeForce GTX 650, AMD Radeon R9 270x • MINIMUM RAM 4GB • HARD DISK SPACE 28GB • DETAILS www.konami.jp/mgs5 • FULL REVIEW Dec 2015

Witcher III: Wild Hunt

★★★★★

£50 inc VAT • store.steampowered.com

Fantasy
RPG

**COMPUTER
SHOPPER**
BEST BUY

The Witcher 3 has an involving plot, an amazingly well-realised world and beautifully drawn characters. It's the ultimate fantasy RPG for anyone that prefers action to turn-based strategy.

AVAILABLE FORMATS PC, Xbox One, PS4 • OS SUPPORT Windows 7/8.1 64-bit • MINIMUM CPU Quad-core 3.3GHz Intel, quad-core 3GHz AMD • MINIMUM GPU Nvidia GeForce GTX 660, AMD Radeon HD 7870 • MINIMUM RAM 6GB • HARD DISK SPACE 40GB • DETAILS www.thewitcher.com/witcher3 • FULL REVIEW Aug 2015

Pillars of Eternity

★★★★★

£35 inc VAT • www.gog.com

Isometric
RPG

**COMPUTER
SHOPPER**
BEST BUY

A proper treat for PC gamers: Pillars of Eternity is a classic RPG for the modern age, which any fan of Baldur's Gate will fall in love with. Expect Beholders, Magic Missiles, demilich demigods and more.

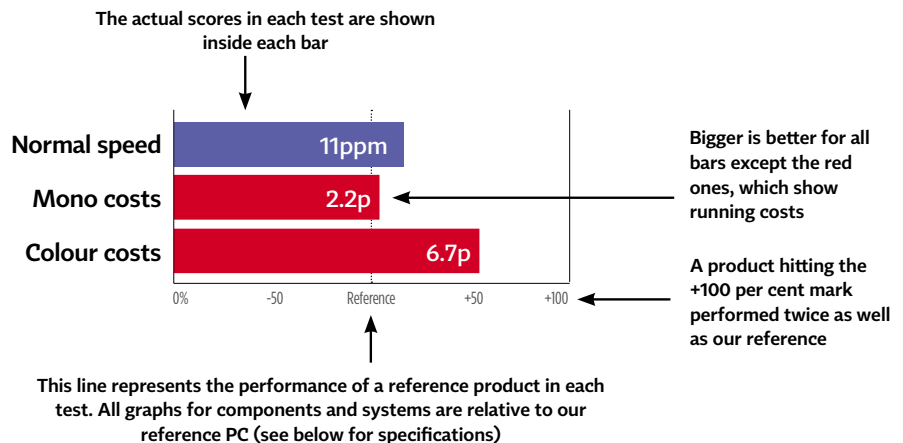
AVAILABLE FORMATS PC, Mac • OS SUPPORT Windows 7/8.1 64-bit, Mac OS X • MINIMUM CPU Dual-core 2.5GHz Intel, dual-core 2.8GHz AMD • MINIMUM GPU Nvidia GeForce GTX 8800GT, AMD Radeon HD 4870 • MINIMUM RAM 4GB • HARD DISK SPACE 14GB • DETAILS www.eterndity.obsidian.net • FULL REVIEW Jul 2015

How we test

Find out how well products perform with the help of *Computer Shopper's* comprehensive tests

COMPUTER SHOPPER'S REVIEWS use some of the most exhaustive testing procedures you'll find in any PC magazine. Every product is subjected to qualitative and quantitative tests that show how it performs in practical use. Graphs for performance, battery-life scores and costs are used in the Reviews section, as shown on the right. Look in the 'Summary of tests' table (below) for details of each test we run.

For PCs and laptops, we evaluate performance using our own custom benchmarking suite. See below for a brief description of our benchmarking software and game tests.



SUMMARY OF TESTS

PC SYSTEMS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAA, Ultra detail
Metro: Last Light Redux	Frames per second at 1,920x1,080, SSAA, Very High detail
LAPTOPS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Processor-intensive multitasking test
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAA, High detail
Battery life	Run time in minutes for continuous video playback
SMARTPHONES/TABLETS	
Battery life	Run time in minutes for continuous video playback
PRINTERS AND MFPs	
Mono text speed	Pages per minute for correspondence-quality text
Mixed colour speed	Pages per minute for presentable text and graphics
Mono page cost	Running costs expressed as pence per page
Colour page cost	Running costs expressed as pence per page
DIGITAL CAMERAS	
Battery life	Number of shots from full charge
CAMCORDERS	
Battery life	Run time in minutes for recording
MP3 PLAYERS	
Battery life	Run time in minutes for continuous playback
ROUTERS	
Laptop 24GHz 10m	Mbit/s at 10m with 802.11n laptop on 24GHz band
Laptop 24GHz 25m	Mbit/s at 25m with 802.11n laptop on 24GHz band
Laptop 5GHz 10m	Mbit/s at 10m with 802.11n laptop on 5GHz band
Laptop 5GHz 25m	Mbit/s at 25m with 802.11n laptop on 5GHz band
802.11ac adaptor 10m	Mbit/s at 10m with an 802.11ac adaptor
802.11ac adaptor 25m	Mbit/s at 25m with an 802.11ac adaptor
NETWORK-ATTACHED STORAGE	
Large files	Average MB/s for read/write of 100MB large files
Small files	Average MB/s for read/write of 100MB small files
HARD DISKS	
Extra large files	Average MB/s for read/write of a single 2.5GB file
Large files	Average MB/s for read/write of 2.5GB of large files
Small files	Average MB/s for read/write of 2.5GB of small files
PROCESSORS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAA, High detail
MOTHERBOARDS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAA, Ultra detail
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAA, High detail
GRAPHICS CARDS	
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4x MSAA, Ultra detail
Tomb Raider	Frames per second at 1,920x1,080, SSAA, Ultra detail
Metro: Last Light Redux	Frames per second at 1,920x1,080, SSAA, Very High detail

BENCHMARKS

SHOPPER BENCHMARKS

Our benchmark suite uses open-source software that runs on Windows, Mac OS X and Linux systems. This lets us use objective results to compare PCs and laptops, no matter which operating system they run. It's designed to test each computer to its limit, using a combination of intensive image-editing, video-encoding and multitasking tests.

We ran the tests on our reference PC, which has an Intel Core i5-4670K processor, 8GB of DDR3 RAM and an AMD Radeon R7 260X graphics card. We normalised our results so this PC had a score of 100. This makes it easy to draw comparisons between test systems.

The resulting overall score is shown at the bottom of every PC and laptop review. As we use the same tests in our standalone and group test reviews, you can compare the performance of any computer, whether it's a netbook, laptop or desktop, from both sections of the magazine.

To see how your computer compares, you can download the suite from www.shopperdownload.co.uk/benchmarks. Versions are available for 32-bit and 64-bit operating systems.

3D BENCHMARKS

DIRT SHOWDOWN

Dirt Showdown is a cracking racing game that makes good use of DirectX 11's fancy graphical effects. You'll want at least 30fps for smooth racing.



TOMB RAIDER

With the ultra-demanding Super-Sampling Anti-Aliasing (SSAA) enabled, 2013's Tomb Raider reboot is a great indicator of mid-range performance.



METRO: LAST LIGHT REDUX

Our most demanding graphics test uses tessellation, SSAA and massive textures to give even high-end cards a thorough workout.



RATINGS & AWARDS

Computer Shopper rates products out of five:

Avoid	☆☆☆☆☆
Below average	☆☆☆☆☆
Good	☆☆☆☆☆
Very good	☆☆☆☆☆
Excellent	☆☆☆☆☆

The best products can win the following awards:

BEST BUY

Products with outstanding quality and performance for the money win our Best Buy award.



RECOMMENDED

Products that don't quite qualify for a Best Buy award but are still highly rated by our reviewers.



BUSINESS

The very best products for work win our Business Buy award.



Product Reviews

193
Reviews

Our guide to all the products reviewed in this month's *Shopper*

Hot Product	24	Components	86	FX-8350	Hard Disks & SSDs	110
Dell XPS 15		Intel Processors	89	FX-8370	Samsung 850 Evo	
		Core i3-4330		FX-9370	Samsung 850 Evo M.2	
PCs & Laptops	26	Core i3-4370		FX-9590	Samsung 950 Pro	
Acer Chromebook R 11		Core i3-6100		Sempron 2650	(NVMe) M.2	
Acer Predator 17		Core i3-6300		Sempron 3850	SanDisk Ultra II	
Asus Chromebit		Core i3-6320			Seagate Laptop SSHD	
Lenovo Yoga 700		Core i5-4440			Western Digital Green	
		Core i5-4460		Cases	97	
Handhelds	32	Core i5-4570		Cooler Master Cosmos SE		
Google Pixel C		Core i5-4590		Corsair Carbide Series	PSUs	114
HTC One A9		Core i5-4670		Air 240	Be Quiet! Dark Power	
Microsoft Display Dock		Core i7-4770		Corsair Graphite 380T	Pro 11 850W	
OnePlus 2		Core i5-4690		NZXT Phantom 530	Corsair RM550	
Vodafone Smart Speed 6		Core i5-4690K		NZXT Source 340	Corsair RM750i	
		Core i5-6400		SilverStone Quiet Precision	EVGA Supernova G2	
Photography	39	Core i5-6500		PS11	750W	
Canon PowerShot G5 X		Core i5-6600			EVGA Supernova GS	
Sony Cyber-Shot RX100 IV		Core i5-6600K		Intel Motherboards	550W	
		Core i7-4790		ASRock Fatal1ty Z170	Super Flower Leadex	
		Core i7-4790K		Gaming K4	Platinum 550W	
Displays	42	Core i7-6700		ASRock H97M Pro4		
Philips Brilliance		Core i7-6700K		ASRock Z97 Extreme6	Software	58
BDM3490UC		Pentium G3420		Asus Z170-A	Serif PagePlus X9	
		Pentium G3430		MSI H81M-E34	Corel Painter 2016	
Home Cinema	44	Pentium G3450		MSI Z170A Gaming M5		
Raumfeld Soundbar		Pentium G3460			Games	60
Samsung UE48JU7500		Pentium G4500		AMD Motherboards	Rise of the Tomb Raider	
		Pentium G4520		Asus A88XM-Plus	Tom Clancy's Rainbow	
Audio	47			Gigabyte GA-990FXA-UD3	Six Siege	
Cowin Ark		AMD Processors	93	Gigabyte GA-F2A68HM-		
Pioneer XDP-100R		A6-7400K		HD2		
		A8-7600		Gigabyte GA-F2A88XN-		
Video	50	A8-7670K		WIFI		
Panasonic HC-VX980		A10-7700K		MSI 970A-G43		
		A10-7800		MSI AM1M		
Printers & Scanners	52	A10-7850K			Graphics Cards	106
Canon i-Sensys MF724Cdw		A10-7870K		AMD Radeon R7 370		
Canon Pixma MG5750		Athlon 5150		AMD Radeon R9 380		
		Athlon 5350		AMD Radeon R9 380X		
Networks	54	FX-6300		Nvidia GeForce GTX 950		
Devolo Home Control		FX-6350		Nvidia GeForce GTX 960		
Starter Pack		FX-8320		Nvidia GeForce GTX 970		
TP-Link Touch P5		FX-8320E		Nvidia GeForce GTX 980 Ti		

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Free software guide

It's easy to access your free software. Just go to www.shopperdownload.co.uk/338 and register with the code from the card insert. Please be aware that you need to have bought the 'Free Software Edition' and not the '£4.50 Edition' to access the downloads

GETTING STARTED

The download instructions on the card insert (after page 74) show you how to connect to the download site. Make sure you type in the web address exactly as shown. You'll need your coupon code the first time you log on to the site.

ANY PROBLEMS

If you need help with any of the software this month, please send an email to letters@computersshopper.co.uk. We check this inbox regularly. Please include the issue number of the magazine and your coupon code.

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**REGISTER YOUR SOFTWARE
BY 17th MARCH 2016**

Serif PagePlus X4

SERIF PAGEPLUS X4 is a versatile desktop publishing tool that's easy to use, yet has all the power you need to bring your creative ideas to life. Browsing the program's bundled templates is a great way to get a feel for its capabilities: there are greetings cards, calendars, newsletters, PDF slideshows, stationery, flyers, posters, photo albums and more – just find a design you like and double-click to get started.

This is very simple. Choose one of the Flyer templates, for instance, and all you have to do is type your own body text, drag and drop a photo, and you're done. But if you'd like to take fine control of your design, there's scope to go further.



Take pictures, for example: if you're unhappy with an image, the built-in PhotoLab offers more adjustments than many specialist editors. There are tweaks for lighting, white balance, sharpness, shadows and highlights, plus tools to fix lens distortion and chromatic aberrations, and a host of special effects.

It's a similar story elsewhere, with tools to draw shapes; apply text effects; insert tables, headers and footers; adjust colours, transparencies and styles; and much more. The well-designed user interface ensures it's all very easy to use and, once you've finished, it's easy to share your work with others.

REQUIREMENTS Windows XP, Vista, 7, 8, 10 32/64-bit, 500MB hard disk space
DETAILS www.serif.com
NOTES Get your registration code at pageplusx4.disc.computersshopper.co.uk



REQUIREMENTS Windows XP, Vista, 7, 8, 10 32/64-bit, 50MB hard disk space
DETAILS www.abelsoft.net
REGISTRATION Get your registration code within the application. Note that if you've already previously registered an Abelssoft application, you won't need to register a second time

Abelssoft GoogleClean 2016

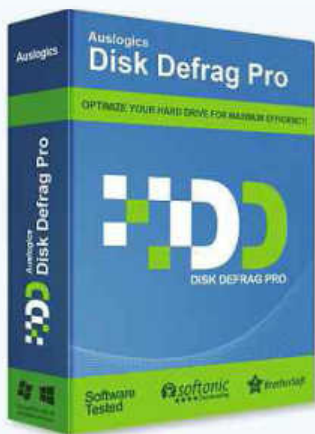
GOOGLECLEAN 2016 is an easy-to-use security tool that checks installed Google apps to ensure they're not giving away your personal information. Launch the program and it looks for any supported software, including Google Desktop, Google Chrome, Google Picasa, Google Earth and Google Toolbar.

GoogleClean checks the privacy settings for every application it finds, then displays a Security Status Summary highlighting any problems. If you're in a hurry, clicking 'Optimize all Google Applications now' reconfigures every program for maximum privacy.

If you'd like more control, there are modules to view regular cookies, Flash cookies, delete some or all of them, and clean up form data and assorted other leftovers. This works well, but as soon as you start using your applications, the junk files will start to build up again, and even your settings might be changed back if you reinstall or update something.



Fortunately, the developer has thought of that. GoogleClean 2016 includes a 'GoogleRadar' module that automatically detects Google traces as they appear and deletes them right away. Just click 'Activate GoogleRadar' to enable the feature.

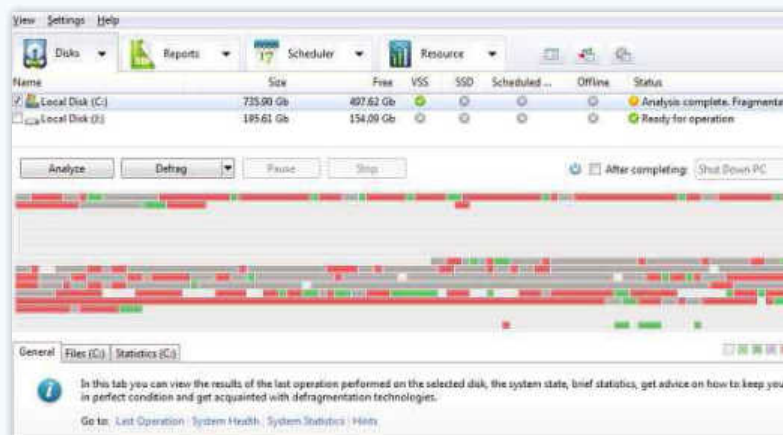


Auslogics Disk Defrag Professional 4

AUSLOGICS DISK DEFRAG Pro 4 is a powerful defrag tool that provides everything you need to keep your system running at peak performance.

The program provides multiple defrag algorithms to boost disk speed. It can optimise access according to file access time, modification time, Windows' own prefetch layout, or you can define which files you'd like written to the fastest part of your drive. Leaving a little free space after specified files also helps to reduce future fragmentation.

There are even more ways to defrag: you might choose to defragment an individual file, a folder, or an entire partition; the program can run before Windows launches, enabling it to defrag system files which would otherwise be locked; a scheduler can run unattended defrags

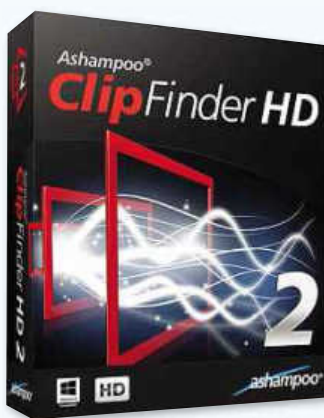


REQUIREMENTS Windows XP, Vista, 7, 8, 10 32/64-bit, 50MB hard disk space
DETAILS www.auslogics.com
NOTES To obtain your serial code, go to ddefrag4.disc.computershopper.co.uk. Includes a full one-year licence

whenever you like, or you can leave Disk Defrag Professional running in the background, so it can eliminate fragmentation as soon as it appears.

The program won't slow you down, either. In just a few clicks you can limit the maximum use

Disk Defrag Professional will make of your CPU or hard drive. And you can tell the program not to run at all when a demanding application is running, so if you launch your favourite games, say, you can be sure they'll get 100% of your system's resources.



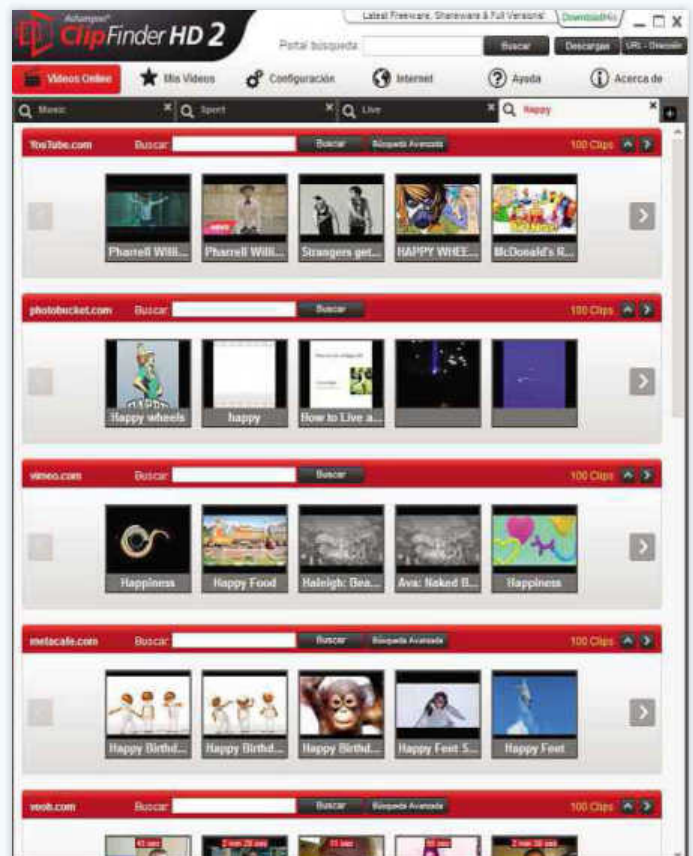
Ashampoo ClipFinder HD 2

ASHAMPOO CLIPFINDER HD 2 is a powerful desktop search engine that finds, downloads, plays and converts your favourite web videos. Getting started is as easy as typing a few keywords and clicking the Search button.

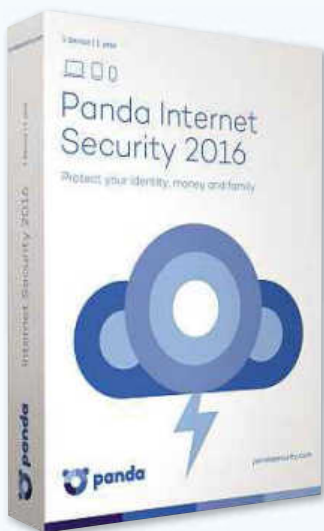
Ashampoo ClipFinder HD 2 then runs parallel searches on YouTube, vimeo, Facebook, Dailymotion, Muzu.tv, veoh, Google Video, metacafe, blip.tv and more. Matching videos are displayed as thumbnails on ClipFinder's 3D video wall. These will start small, but spinning the mouse wheel zooms in.

If you see something interesting, double-clicking opens it in the video player where you can watch it as usual (preview or full-screen), copy its URL to the clipboard, open the source page in a browser or bookmark the movie for easy recall later.

A built-in Download Manager grabs a local copy of the clip on demand. Downloaded videos can be stored in ClipFinder's library, where you can organise them into playlists or categories.



REQUIREMENTS Windows XP, Vista, 7, 8, 10 32/64-bit, 50MB hard disk space
DETAILS www.ashampoo.com
NOTES Get your registration code within the application



Panda Internet Security 2016



PANDA INTERNET SECURITY

2016 is a capable security suite with protection for Windows, Android, iOS and Mac.

The Windows module offers accurate anti-virus, browser

protection (via an optional toolbar), a firewall and Wi-Fi protection to detect intruders on your network. The Data Shield prevents sensitive data falling into

the wrong hands, parental controls keep your kids safe online, and there's a virtual keyboard to bypass keyloggers.

Mac and iOS protection is more basic, with anti-virus and an iPhone location service, while the Android tools take this a little further: anti-virus, device optimisation, a location service, and the option to lock or wipe your device remotely.

All this is easy to set up, but look out for the option to install a browser toolbar: it will change your home and search pages unless you clear some tickboxes.

After that, the program proves as reliable and accurate as ever. The 2016 edition brings new checks for Wi-Fi vulnerabilities, a new engine, and smarter Collective Intelligence, offering greater protection with less impact on performance.



REQUIREMENTS Windows XP, Vista, 7, 8, 10 32/64-bit, 200MB hard disk space
DETAILS www.pandasecurity.com
NOTES Six-month licence



CyberLink PowerDirector 12 LE

POWERDIRECTOR 12 LE is a comprehensive video editor that's extremely easy to use, and gives you many different ways to present and share your media.

The capable slideshow creator lets you import your photos, and choose a slideshow style such as Camera, Normal or Motion. Preview the slideshow to see its animations and effects, and when you're happy, export the results as a video file.

An Easy Editor works in a similar way, only it accepts video clips as well as photos. Choose your source files, drag and drop to reorder them, select a custom style and preview the results. Again, your production can be saved as a video, ready to share with others, in just a few clicks.

If you need more control, though, the real power is in the full editor. Here you're able to import all the images and videos you need, before organising them on a multitrack timeline.

You can then trim your clips, split them into separate scenes

and improve them by fixing lighting problems, stabilising footage or removing noise. There are also tools to adjust exposure, brightness, contrast, hue, saturation, sharpness, vibrancy and a whole lot more.

Your project can be previewed at any time, making it easy to see how you're progressing, and when you've finished your film can be exported as a video file or uploaded directly to Facebook, YouTube, Dailymotion or Vimeo.



REQUIREMENTS Windows XP, Vista, 7, 8, 10 32/64-bit, 500MB hard disk space
DETAILS www.cyberlink.com
NOTES Get your registration code at pdr12.disc.computershopper.co.uk

Chat and Communication

Digsby (Build 92) Access all your instant messaging services from one application; there's support for Windows Live!, Yahoo!, AIM, Google Talk, ICQ and Jabber.

Evernote 5.9.6 Store your notes, ideas and plans in the cloud, and synchronise them between computers.

UPDATED Mozilla Thunderbird 38.5 A powerful email client from the organisation best known for the Firefox web browser.

Postbox Express 1.0.1 An email client that provides a comprehensive array of tools to help you manage your messages more easily.

Skype for Windows 7.18 Make internet voice and video calls for free, and buy credit to make calls to mobiles and landlines.

Trillian 5.6 Use all your instant messaging accounts with one application; this program has support for Windows Live!, AIM, Yahoo! and Google Talk.



Customisation

7 Taskbar Tweaker 5 Customise the Windows 7 taskbar so that it works exactly to your liking.

Metro UI Tweaker for Windows 8 Tweak the Windows 8 user interface.

Mosaic Desktop Beta 1 Refresh

Add Windows 8's mosaic-tiled desktop to your computer without having to upgrade.

UPDATED Rainmeter 3.3 Customise the desktop quickly and easily with your choice of information, tools and shortcuts.

Windows 8 Transformation Pack 9.1

Emulate the look of Windows 8 on an earlier version of the operating system.

Windows 10 Transformation Pack 6

Bring some of Windows 10's new features to your current operating system.



General

UPDATED Free Studio 6.6 This software provides an easy way to convert your video and audio files into different formats.

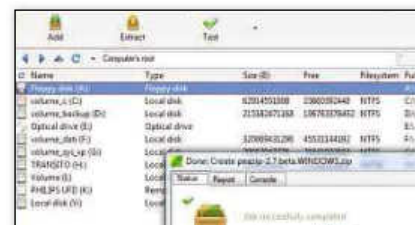
Paragon Partition Manager 14 Free Create, format, split, merge and reorganise all your hard disk's partitions.

PeaZip 5.9.1 A tremendously powerful archive-management tool.

Screenshot Captor 4.16 Create and manage screenshots the easy way.

UPDATED SUMo 4.2.7 Quickly scan your PC's installed applications and find any updates that are available for them.

ZipGenius 6.3 A flexible file-compression tool with support for a huge number of compressed file formats.



Internet and Network

CarotDAV 1.12.4

Manage all your online storage services with one simple application.

Cyberduck 4.7.3

A powerful but easy-to-use FTP client for uploading and downloading your files.

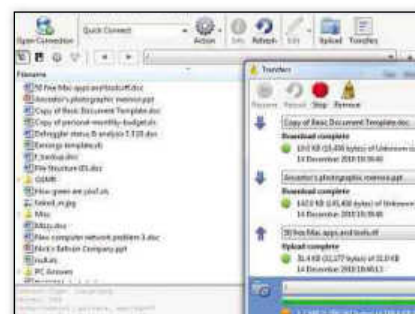
Easy WiFi 4.0

Find free Wi-Fi hotspots while you're out and about.

NetBalancer 9.1.4 Make the most of your internet connection by assigning download and upload priorities to web applications.

TeamViewer 11 Remote-control your computer from anywhere in the world.

Vuze 5.7 A BitTorrent client to help you locate, share and download torrent files.



Tweaking and Performance

UPDATED CCleaner 5.13 Remove unwanted information, temporary files, browsing history, huge log files and even the settings that uninstalled software leaves behind.

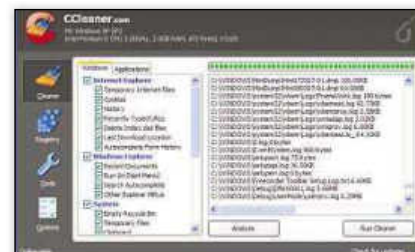
Defraggler 2.19 Ensure your system is defragmented properly and improve its performance.

Finestra Virtual Desktops 2.5 Set up four or more virtual desktops on your PC.

UPDATED IObit Advanced SystemCare 9.1 A complete computer security, maintenance and optimisation suite.

Revo Uninstaller Free 1.95 Remove installed applications completely, including all their folders, system files and Registry entries.

Simple Performance Boost 1.0.5 Tweak the Windows Registry to give your PC a performance boost.



Crafting PCs the Scan way: Specification. Service. Satisfaction.



Scan V1 Value System Home / Office PC

- Intel® Pentium® G4400 processor
- 4GB Corsair DDR4 2133MHz memory
- 500GB SATA 6Gb/sec hard drive
- Windows 10

£309 Inc VAT

The V1 is a very capable entry-level system perfect from basic home/office tasks. It's based around the dual-core Intel® Pentium® G4400 processor, 4GB of RAM plus a 500GB hard disk.



Scan V15 Value System Home / Office PC

- Intel® Core™ i5 4460 processor
- 8GB Corsair DDR3 1600MHz memory
- 1TB SATA 6Gb/sec hard drive
- Windows 10

£469 Inc VAT

The V15 ups the ante by including a quad-core Intel® Core™ i5 4460 processor, so it makes light work of office and multimedia applications.

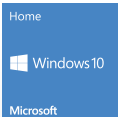


Scan G20 Value System Gaming PC

- Intel® Pentium® G4400 processor
- 8GB Corsair DDR3 1600MHz memory
- 2GB NVIDIA GeForce GTX 750 Ti SSC
- 1TB SATA 6Gb/sec hard drive
- Windows 10

£499 Inc VAT

Thanks to its dual-core Intel® Pentium® G4400 processor and NVIDIA GTX 750 Ti SSC graphics card the G20i is our most affordable gaming PC. It even includes surround sound!

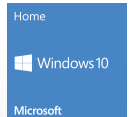


Scan G30i Value System Gaming PC

- Intel® Core™ i5 4460 processor
- 8GB Corsair DDR3 1600MHz memory
- 2GB NVIDIA GeForce GTX 960 SSC ACX
- 1TB SATA 6Gb/sec hard drive
- Windows 10

£649 Inc VAT

The combination of quad-core Intel® Core™ i5 4460 processor and NVIDIA GeForce GTX 960 SSC ACX graphics card ensures that the G30i can play any game you throw at it.



Windows 10. Do great things.



Scan Value PCs

A range of computers perfectly suited for the home/office. These affordable PCs are very flexible workhorses, capable of every task, from email/web surfing to high-end applications such as photo editing, video encoding and gaming. All of our Value Systems are pre-built and soak-tested so are ready to ship for next-day delivery.



Finance Available on
PCs above £300



Built by award
winning 3XS team



Fully soak tested



Fully 3XS
compatible



Ready to ship



2 Year Warranty
Part + Labour



The most awarded PCs and Laptops Period.

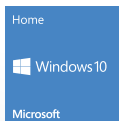


Scan 3XS Gamer 20i Gaming PC

- Intel® Core™ i7 4790 processor
- 8GB Corsair DDR3 2133MHz memory
- 4GB NVIDIA GeForce GTX 970 SC ACX
- 1TB Seagate HDD
- Windows 10
- 3 Year Premium Warranty

£999 Inc VAT

The 3XS Gamer 20i is a super-fast gaming PC thanks to its combination of quad-core Intel Core i7 4790 CPU running at 3.6GHz with added Hyper-Threading plus a 4GB NVIDIA GeForce GTX 970 graphics card. These components are installed in an Asus Z97-P motherboard along with a 1TB hard disk.

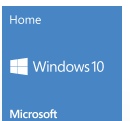


Scan 3XS Vengeance Gaming PC

- Intel® Core™ i7 6700K processor overclocked up to 4.7GHz
- 8GB Corsair DDR3 2133MHz memory
- 4GB NVIDIA GeForce GTX 980 SC
- 250GB Samsung 850 SSD & 2TB HDD
- Windows 10
- 3 Year Premium Warranty

£1459 Inc VAT

This high-end gaming system includes a Intel Core i7 6700K CPU which has Hyper-Threading and is overclocked up to 4.7GHz plus a 4GB NVIDIA GeForce GTX 980 graphics card, 8GB of 3000MHz Corsair Vengeance DDR4, an Asus Z170 Pro Gaming motherboard, 256GB SSD and a 2TB hard disk.

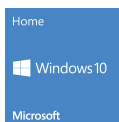


3XS LG15 Performance GTX

- Intel® Core™ i7 6700HQ processor
- 8GB Corsair DDR3 1600MHz memory
- 2GB NVIDIA GeForce GTX 960M
- 15.6in 1,920 x 1,080 screen
- 1TB SATA 6Gb/sec hard drive
- Windows 10

£869 Inc VAT

The LG15 Performance GTX is a 15.6" mid-range gaming laptop that includes a NVIDIA GeForce GTX 960M graphics card plus your choice of Intel Core i5 or i7 CPU, up to 16GB of RAM and multiple hard disks and SSDs.

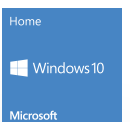


3XS LG15 Carbon G-Sync

- Intel® Core™ i7 6700 processor
- 8GB Corsair 2133MHz DDR4 memory
- 6GB NVIDIA GeForce GTX 970M or 980M
- 15.6in FullHD or 4K screen
- 1TB SATA 6Gb/sec hard drive
- Windows 10

£1309 Inc VAT

The LG15 Carbon G-Sync is a 15.6" high-end gaming laptop that includes a NVIDIA GeForce GTX 970M or 980M graphics card with your choice of Intel Core i5 or i7 CPU, up to 32GB of DDR4 and multiple hard disks and SSDs plus NVIDIA G-Sync for tearing and stutter free gaming.



Scan Computers recommends Windows.

3XS Custom Series

Our 3XS Custom Series is a range of computers designed to offer the best performance for a variety of applications, with a particular focus on games. We build Custom Series PCs to order, so we can configure and tailor make an individual PC just the way you want it. We can also overclock the processor, so you get a faster PC without a substantial increase in price. All 3XS Custom Series PCs are covered by a three year warranty as standard with the first year on-site.



Scan 3XS Overclocked



Built by award winning 3XS team



3 Year Warranty

3XS SYSTEMS



BUILDING BLOCKS

Components

If you want to build your own computer, there's never been a better time. We take you through the ultimate components to help you make the best choices

CONTENT REVIEWS

Page 87

PROCESSORS

Page 88

RAM

Page 97

CASES

Page 100

MOTHERBOARDS

Page 106

GRAPHICS CARDS

Page 110

HARD DISKS & SSDs

Page 114

POWER SUPPLIES

ONE OF THE best things about the humble desktop PC is its modular structure, giving you the flexibility to build a computer that matches your needs. Make the right choices and you'll have a brilliant PC that will last for years, plus the ability to upgrade it in future to make it last even longer. With Windows 10 impressing, now's the perfect time to get a new computer to go with the new OS.

Making the right choice isn't always easy, though, with hundreds of products to choose from. In this issue, we're here to help with our in-depth guide to all of the best components. By the time you've finished reading, you'll be able to put together a perfect shopping list that matches your needs and budget.

We're doing things a little differently this year. A lot of product categories (graphics cards, cases, hard disks and so on) have an

overwhelming number of products to choose from. So this year we've tested hundreds of products, but to make the choices simple in many categories, we're only presenting you with the best products to choose from, and we're not giving over pages to products that we can't recommend. This means that we can recommend more top products to suit all budgets, rather than devoting pages to poor products. We're still bringing you comparison tables and, where appropriate, performance graphs, so you can easily choose the product that you want, confident in the knowledge that we're recommending the best.

We hope the results are clearer and easier to follow, making it quicker for you to find the right components. Don't forget to come back next month, as we'll have our complete guide to building your PC from scratch.

CHIPPING IN

Processors

A great processor is about more than the specs you see on paper. We've tested every major CPU from AMD and Intel to find the best ones to match your needs

THE PROCESSOR IS arguably the most important part of your computer. It dictates how fast it is today and, as a result, how long it will last. This is one section where we're presenting the results of all of our testing, too. The simple reason is that processor prices fluctuate a lot and similar models tend to have very close prices. As a result, a processor we recommend today can rise in price, while the model below, which may only be a little slower, may dramatically drop in price, making it the better buy. Our main advice is to check the prices of the models surrounding our recommended choices to see if you can get a better deal. To make sure you're comparing the right models, use the product code (listed in our tables on pages 92 and 96) when using price comparison sites.

NEW MODEL ARMY

There are a lot of different processors out there, with older ranges still on sale years after they first came out. However, a lot of older models aren't good value and don't perform as well as their newer siblings. As a result, we've only reviewed ranges that are still currently available and are worth buying.

Each manufacturer and product range has its own individual CPU architecture (our reviews explain more), but all models share certain features. Understanding these will help you make the right decision and choose the model that best fits your needs.

First, there's the processor's clock speed, which is often set as an indicator of the CPU's speed. However, this can be misleading, as clock speed is only a useful gauge when comparing processors in the same range, particularly as many chips have a low starting clock speed, but can boost higher when they need to perform a demanding task. Instead, it's the processors' efficiency and number of cores that dictate how quick it will be.

A core is a processor in its own right, so the more cores there are, the more power your computer has at its fingertips. To use multiple cores you either have to run multiple applications at once, or use applications that take advantage of the multiple cores. The latter are called multithreaded applications, and are typically used for processor-intensive tasks such as video editing.

Multithreaded support has become better in recent years, with applications able to use eight cores easily. Even if you don't run a lot of these types of application, multiple cores are useful: you can run a virus scan using one



core, for example, while the others are used for web browsing and other tasks. All the processors we've reviewed here have at least two cores, but quad-core, six-core and eight-core models are also here.

Some Intel processors use Hyper-Threading technology, which doubles the number of cores available by adding one logical core per real core. Virtual cores help speed up applications and let the processor do more, making it more efficient, but they're not as good as real physical cores.

Some processors (our tables on pages 92 and 96 confirm which ones) can automatically overclock themselves when they're cool enough, giving you a free speed boost. Intel calls its technology Turbo Boost; AMD calls its version Turbo Core.

CACHE MACHINE

All computers have system memory, which is used to store open applications and data. However, it tends to be relatively slow; that is, too slow for a CPU. This is why processors have cache. Level 1 (L1) cache is the fastest and smallest, and each core has its own. L2 cache is available in larger sizes and isn't as

quick as L1. Each core generally has its own L2 cache, although some models share this between multiple cores. Finally, L3 is the slowest type of cache, but is available in much bigger sizes. It's shared between all cores. When a core needs to access something from memory, it first checks the L1 cache, then the L2 cache and then the L3 cache, only going to system memory if it can't find what it wants.

The amount of cache, therefore, has a significant impact on performance, as it reduces the time that a processor has to wait for system memory. The more L3 cache you have the better, as cores often have to access the same bit of memory, so having shared cache helps speed up all cores.

SKYLAKE'S THE LIMIT

Intel usually releases a new architecture a year, but last year it was so late with the updated Broadwell that these chips aren't worth bothering with. Instead, the current range uses the new Skylake architecture, which require a motherboard with the H170 or Z170 chipset and the LGA1151 socket.

The previous-generation Haswell processors fit into the LGA1150 socket and



will work with any of our recommended LGA1150 motherboards this month; note that some older boards don't support Haswell, so check specs carefully if you're buying something we haven't listed.

We've also listed the Devil's Canyon processors, which are an update to Haswell with faster speeds. They're very quick, which is why we've listed them here. These processors use the LGA1150 socket, but require the Z97 or H97 motherboard chips.

Haswell-E is also available, but we haven't reviewed these chips as they're poor value and require expensive motherboards with the LGA2011 socket. Simply put, Haswell-E is for high-end enthusiasts, but they're a little too niche for us to recommend now.

Intel's chips all share some common features based on the product name: Pentium, Core i3, Core i5 or Core i7. Pentium chips are dual-core models; Core i3 are dual-core with Hyper-Threading; Core i5 are quad-core and have Turbo Boost; and Core i7 are quad-core with Hyper-Threading and Turbo Boost. In all cases look out for chips with a 'K' in the name, as these have unlocked multipliers, so you can overclock them easily.

Finally, all Intel chips we've reviewed have integrated graphics. The graph on the opposite page shows you how well each graphics chipset performs; the short answer is that integrated graphics are fine for older titles, but if you want to play the latest games, you'll need a graphics card (see page 106).

SPECIAL FX

AMD hasn't revamped its product range as much as Intel, but there are still a number of good-value options to choose from. AMD's processors are available roughly as two types: those with graphics and those without. The latter are all FX chips and are designed for AM3+ motherboards. Cheaper FX chips are quad-core, but the more powerful chips have six or eight cores. The current FX generation is known as Piledriver and uses Vishera cores. Look out for these, as they're superior to the earlier Bulldozer chips with their Zambezi cores, which we haven't reviewed.

FX chips can't match the fastest Intel processors for raw power, but they're a lot cheaper and, per pound, outshine their rivals. The six- and eight-core models are great chips for serious computing tasks.

FX processors have unlocked multipliers, so you can overclock them easily if you're feeling adventurous and want more power.

All the other AMD processors we've tested are called Application Processing Units (APUs), which means they combine graphics with a processor. There are three generations of A-series (processors starting with an A) APU on the market. Trinity and Richland can be used in Socket FM2 motherboards, while the newer Kaveri processors need an FM2+ board.

A-series chips aren't as powerful as Intel chips or the FX range, but their integrated graphics are very good. All but the cheapest processor managed our Dirt Showdown test, playing it smoothly at a 720p resolution. This means that you can play some decent games without having to buy a graphics card, making A-series processors brilliant all-rounders. These chips are either dual- or quad-core.

Finally, there are the newer FM1 chips, which are AMD's budget offering. These require an FM1 motherboard. These chips are very slow and the graphics are only really good enough for playing video. However, if you're looking to build a small computer for light computing tasks, they're a good option.

RAM RAID Memory

IN PREVIOUS YEARS we've reviewed RAM kits, but we found that performance was so similar across the board that the only real differences came down to price and capacity. We therefore don't see the point in reviewing RAM kits. Instead, we'll guide you through choosing the right RAM for your system.

PAST MEMORIES

DDR3 is by far the most common type of RAM available. It's used by all AMD processors as well as Intel Haswell and Devil's Canyon. However, if you're building a Skylake system, you'll need to use DDR4 RAM. Before you buy, check your motherboard's specs to find out which memory it requires, as the two standards aren't compatible with each other. Our motherboard guide on page 100 clearly lists which type of RAM is needed.

RAM can run at different speeds, which is usually quoted in megahertz, such as 1,333MHz. However, RAM can also be sold using a different numbering system, which is eight times higher than the MHz speed. For example, 1,333MHz DDR3 is also sold as PC3-10600. The faster the MHz rating, the faster the RAM, but it may make your PC only a tiny fraction faster overall: don't expect huge speed improvements from buying the fastest RAM you can find.

Your motherboard supports a maximum RAM speed; install any faster RAM and it will simply run at the slower speed. Finally, your motherboard may not run your memory at the correct speed when you first plug it in, so

you should enable the Intel Extreme Memory Profile (XMP) or AMD Memory Profile (AMP) in your motherboard's BIOS or UEFI to unlock the faster speeds.

At current prices, DDR3 1,866MHz is the best value and suits everything from entry-level to high-end computers, running at 1,600MHz on lower-spec PC. For DDR4, 2,400MHz is the best value, while 3,200MHz is the best choice for performance.

AFTER EIGHT

You need to know how much RAM you want. Generally speaking, 8GB is ideal for a budget system. Mid-range or high-end users should opt for 16GB; 32GB will be overkill for most people. More RAM won't speed up your PC, but it means you can run more applications

and open bigger files without any slow-down. If you play lots of games, edit videos or run loads of applications, you should go for 16GB.

Most motherboards support dual-channel memory, which means you insert memory in pairs. You can buy kits that contain two or four sticks of RAM to get you to 8GB, 16GB or higher. For the memory sizes we currently recommend, 2x 4GB (8GB) and 2x 8GB (16GB) are generally the best options. Check prices carefully, though, as we've seen instances where buying two 8GB kits (four sticks of RAM) was cheaper than one 16GB kit.

Finally, check the maximum amount of RAM your motherboard supports (see the tables on pages 102-105) and don't go over this limit.

RECOMMENDATIONS

From long experience, it's best to buy branded RAM from recognised manufacturers. Corsair, Crucial and Kingston all make high-quality products. Below are a few to start with.

DDR3					
PRODUCT NAME	PART CODE	SPEED	CAPACITY	PRICE	SUPPLIER
HyperX 8GB 1,866MHz DDR3	HX318C10FRK2/8	1,866MHz	8GB (2x 4GB)	£33	www.ebuyer.com
HyperX Blue Fury Series 16GB 1866MHz	HX318C10FK2/16	1,866MHz	16GB (2x 8GB)	£64	www.ebuyer.com
DDR4					
PRODUCT NAME	PART CODE	SPEED	CAPACITY	PRICE	SUPPLIER
Corsair Vengeance LPX 8GB 3,200MHz	CMK8GX4M2B3200C16R	3,200MHz	8GB (2x 4GB)	£66	www.ebuyer.com
Corsair Vengeance LPX 8GB 3,200MHz x2	CMK8GX4M2B3200C16R	3,200MHz	16GB (2x 8GB kits as above)	£132	www.ebuyer.com
Corsair Vengeance LPX 8GB 2,400MHz	CMK8GX4M2A2400C14R	2,400MHz	8GB (2x 4GB)	£43	www.ebuyer.com
Corsair Vengeance LPX 16GB 2,400MHz	CMK16GX4M2A2400C14R	2,400MHz	16GB (2x 8GB)	£78	www.ebuyer.com

All prices include VAT

INTEL Haswell

HASWELL IS A couple of years old, but there are still quick processors available and the range is compatible with DDR3 memory and older motherboards; by contrast, newer Skylake chips require DDR4 memory and new motherboards. As a result, Haswell can be a good choice for anyone that has some old kit they want to use in a new build.

All Haswell processors use the LGA1150 processor socket, so you'll need to buy a matching motherboard (see our guide to motherboards starting on page 100). Haswell is a tweak of the previous-generation Ivy Bridge architecture, and uses the same 22nm fabrication process. Intel has pushed for speed in this range, although that means it requires slightly more power. Both the Core i5 and Core i7 ranges have a power rating of 84W TDP, while the Core i3 and Pentium Dual Core ranges consume less power, with 54W and 53W TDPs respectively.

ARCHITECTURE AND PERFORMANCE

There are five types of Haswell processor, denoted by a model range name. At the low end is the Celeron range, which we haven't reviewed here, as the chips aren't good value. That leaves us with the budget Pentium, low-end Core i3, mid-range Core i5 and high-end Core i7 chips.

All share the same basic architecture, with 64KB of L1 cache and 256KB of L2 cache per core. The amount of L3 cache, which all cores share, varies between 3MB and 8MB depending on the number of cores and processor type (our table on page 92 shows you the full details).

With more cache, a processor spends less time accessing slow system memory, speeding up processing. As multiple cores often have to access the same bit of memory, more L3 cache is a great way to speed up a PC.

The big differences in processors come from the number of cores and whether there's Hyper-Threading or not. Hyper-Threading is Intel's technology for doubling the number of real cores that a processor has with additional virtual cores. For example, a quad-core processor appears to Windows as an



HASWELL					
MODEL	FREQUENCY (TURBO)	CORES	RATING	PRICE	BENCHMARK SCORE
Pentium G3420 <small>COMPUTER SHOPPER RECOMMENDED</small>	3.2GHz	Two	★★★★☆	£54	41
Pentium G3430	3.3GHz	Two	★★★★☆	£70	43
Pentium G3450	3.4GHz	Two	★★★★☆	£66	44
Pentium G3460	3.5GHz	Two	★★★★☆	£68	45
Core i3-4330	3.5GHz	Two plus two logical (Hyper-Threading)	★★★★☆	£116	57
Core i3-4370 <small>COMPUTER SHOPPER RECOMMENDED</small>	3.8GHz	Two plus two logical (Hyper-Threading)	★★★★☆	£116	61
Core i5-4440	3.1GHz (3.3GHz)	Four	★★★★☆	£148	91
Core i5-4460	3.2GHz (3.4GHz)	Four	★★★★☆	£143	94
Core i5-4570	3.2GHz (3.6GHz)	Four	★★★★☆	£159	94
Core i5-4590 <small>COMPUTER SHOPPER BEST BUY</small>	3.3GHz (3.7GHz)	Four	★★★★★	£156	97
Core i5-4670	3.4GHz (3.8GHz)	Four	★★★★★	£172	100
Core i7-4770	3.5GHz (3.9GHz)	Four plus four logical (Hyper-Threading)	★★★★☆	£243	125

eight-core CPU. These virtual cores help make the CPU more efficient and can hasten tasks that can use multiple cores at once.

In the Haswell range the Pentium chips are dual-core, the Core i3 models are dual-core with Hyper-Threading, the Core i5 CPUs are quad-core and the Core i7 chips are quad-core with Hyper-Threading.

Core i5 and Core i7 chips also have Intel's Turbo Boost technology. This lets them automatically overclock themselves when there's enough thermal headroom (which is a good reason to fit a decent cooler), improving performance.

Processors with a 'K' in the model name are unlocked, so you can manually adjust the multiplier to speed up the CPU; however, at the time of writing we couldn't find any of these models for sale. This is the only safe

way to overclock, as adjusting the external bus speed also affects the graphics and RAM.

ONBOARD GRAPHICS

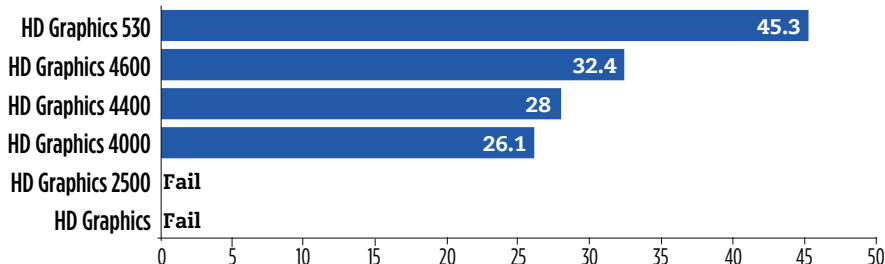
Intel boosted the quality of its onboard graphics for Haswell, although the company still lags behind AMD in this regard. Most of the chips in the range use the Intel HD Graphics 4600 GPU, which is good enough to play some older games at a resolution of 1,280x720 (see graph below). The Intel HD Graphics 4400 is only a little slower, but anything below this isn't going to be good enough to play games. All graphics chips can cope with decoding HD video, and they all support the HDMI 1.4a standard.

VERDICT

Skylake is the fastest architecture and its chips aren't that much more expensive, so it's the best choice for most people. However, as we said, if you have some older kit you want to reuse, such as DDR3 memory, Haswell is a good choice. We think the Core i7 range is a little expensive and doesn't give enough of a performance boost over the i5 range.

The Core i5-4590 offers the best performance for the price, and wins a Best Buy award. If you want to save a little money, the Core i3-4370 is great value and still quick. Those looking to build a budget computer with decent power should go for the Pentium G3420. Both the Core i3-4370 and the Pentium G3420 win Recommended awards.

Dirt Showdown 1,280x720, High detail, 4x AA (fps)



INTEL

Devil's Canyon

ONE ISSUE WITH Intel's Haswell processors was that they weren't that much faster than the previous generation. Intel looked to fix that with its Devil's Canyon line of CPUs.

ARCHITECTURE AND PERFORMANCE

Although the internal architecture of Devil's Canyon CPUs is the same as Haswell processors, Intel used a new thermal interface material. This reduces the heat of the CPU, increasing how far the clock speed can be pushed. This is particularly important for the 'K' variety of the chips: when we tested the 4GHz Core i7-4790K, we managed to push it to 4.7GHz using the stock Intel cooler.

Turbo Boost technology lets the processor overclock itself when there's enough thermal headroom; with Devil's Canyon, the chips can boost higher for longer.

Using Devil's Canyon requires a motherboard with an Intel Z97 or H97 chipset, although the chips will work on some 8-series motherboards provided they have a BIOS update. Check your motherboard manufacturer's website for more details.

DEVIL'S CANYON					
MODEL	FREQUENCY (TURBO)	CORES	RATING	PRICE	BENCHMARK SCORE
Core i5-4690	3.5GHz (3.9GHz)	Four	★★★★☆	£173	103
Core i5-4690K <small>COMPUTER SHOPPER BEST BUY</small>	3.5GHz (3.9GHz)	Four	★★★★★	£189	103
Core i7-4790	3.6GHz (4GHz)	Four plus four logical (Hyper-Threading)	★★★★☆	£245	129
Core i7-4790K	4GHz (4.4GHz)	Four plus four logical (Hyper-Threading)	★★★★☆	£269	143

ONBOARD GRAPHICS

Devil's Canyon doesn't change the onboard graphics, with all the chips using Intel HD Graphics 4600 chips. This is fast enough for some light gaming and video playback, but you'll want to upgrade to a dedicated graphics card to play the latest titles.

VERDICT

Skylake has a slight edge, but Devil's Canyon chips are fast and don't require DDR4 RAM, making them a good choice for anyone with old RAM they want to reuse. There are only four models of Devil's Canyon chips at the moment, with the Core i7 range incredibly fast but extremely expensive. The Core i5-4690K hits the sweet spot between performance and price, and it's unlocked so you can overclock it. It wins a Best Buy award.



INTEL

Skylake

AFTER BROADWELL WAS late, Intel jumped straight to Skylake, it's brand-new architecture. As it stands, Skylake is the range that most people should buy, offering the best range and the fastest processors.

Skylake uses a 14nm fabrication process, which means chips run relatively cool and use less power than the Haswell equivalents: just 47W TDP for the low-end Pentium processors, rising to 65W for the locked Core i5 and i7 processors. The unlocked and overclockable 'K' models have a high 91W TDP, as they're designed to deliver the best performance.

ARCHITECTURE AND PERFORMANCE

Skylake comes in four versions. At the bottom are the Pentium dual-core models; next comes the low-cost Core i3, which is dual-core but has Hyper-Threading; next are Core i5 chips, which have four cores and Turbo Boost; finally, the Core i7 has four cores, Hyper-Threading and Turbo Boost. Intel has tweaked the way Turbo Boost works, with the maximum boost changing based on the number of cores being used: a single core can be pushed higher than four cores together, for example.

Other than that, the basics are the same as Haswell, with 64KB of L1 and 256KB of L2 cache per core, and between 3MB and 8MB of L3 shared cache, depending on the model (see the table on page 92 for details).

SKYLAKE					
MODEL	FREQUENCY (TURBO)	CORES	RATING	PRICE	BENCHMARK SCORE
Pentium G4500 <small>COMPUTER SHOPPER RECOMMENDED</small>	3.5GHz	Two	★★★★☆	£66	49
Pentium G4520	3.6GHz	Two	★★★★☆	£74	50
Core i3-6100	3.7GHz	Two	★★★★☆	£94	65
Core i3-6300	3.8GHz	Two	★★★★☆	£117	67
Core i3-6320 <small>COMPUTER SHOPPER RECOMMENDED</small>	3.9GHz	Two	★★★★☆	£126	69
Core i5-6400	2.7GHz (3.3GHz)	Four	★★★★☆	£147	87
Core i5-6500 <small>COMPUTER SHOPPER RECOMMENDED</small>	3.2GHz (3.6GHz)	Four	★★★★★	£160	103
Core i5-6600	3.3GHz (3.9GHz)	Four	★★★★☆	£177	107
Core i5-6600K <small>COMPUTER SHOPPER BEST BUY</small>	3.5GHz (3.9GHz)	Four	★★★★★	£198	113
Core i7-6700	3.4GHz (4GHz)	Four	★★★★☆	£263	131
Core i7-6700K <small>COMPUTER SHOPPER RECOMMENDED</small>	4GHz (4.2GHz)	Four	★★★★☆	£319	155

It's the other parts of the processor where things change. The on-chip memory controller now supports DDR4 memory, although there's a DDR3 controller for the few motherboards that support it; most people will need to upgrade to DDR4. The full integrated voltage regulator (FIVR) introduced with Haswell has been removed, so overclockers now have full voltage control through their motherboard. To use Skylake you need a new motherboard that supports the chip: an LGA1151 socket and either a Z170 or H170 chipset is required.

ONBOARD GRAPHICS

Most of the range has Intel HD Graphics 530 chips, which is an improvement over Haswell's integrated chips. The result is that light

gaming is definitely a possibility without having to buy an additional graphics card. Of course, media playback is completely fine without a graphics card.

VERDICT

If you want the best performance, the unlocked Core i7-6700K can't be beaten, although it is quite expensive. For most people, the Core i5-6600K will do the job. Both win a Best Buy award. If you're not interested in overclocking, the Core i5-6500 is great value and very quick. If you're looking for a quick, lower-cost chip, the Core i3-6320 is great, while those on a tighter budget should go for the Pentium G4500. All of these processors win a Recommended award.

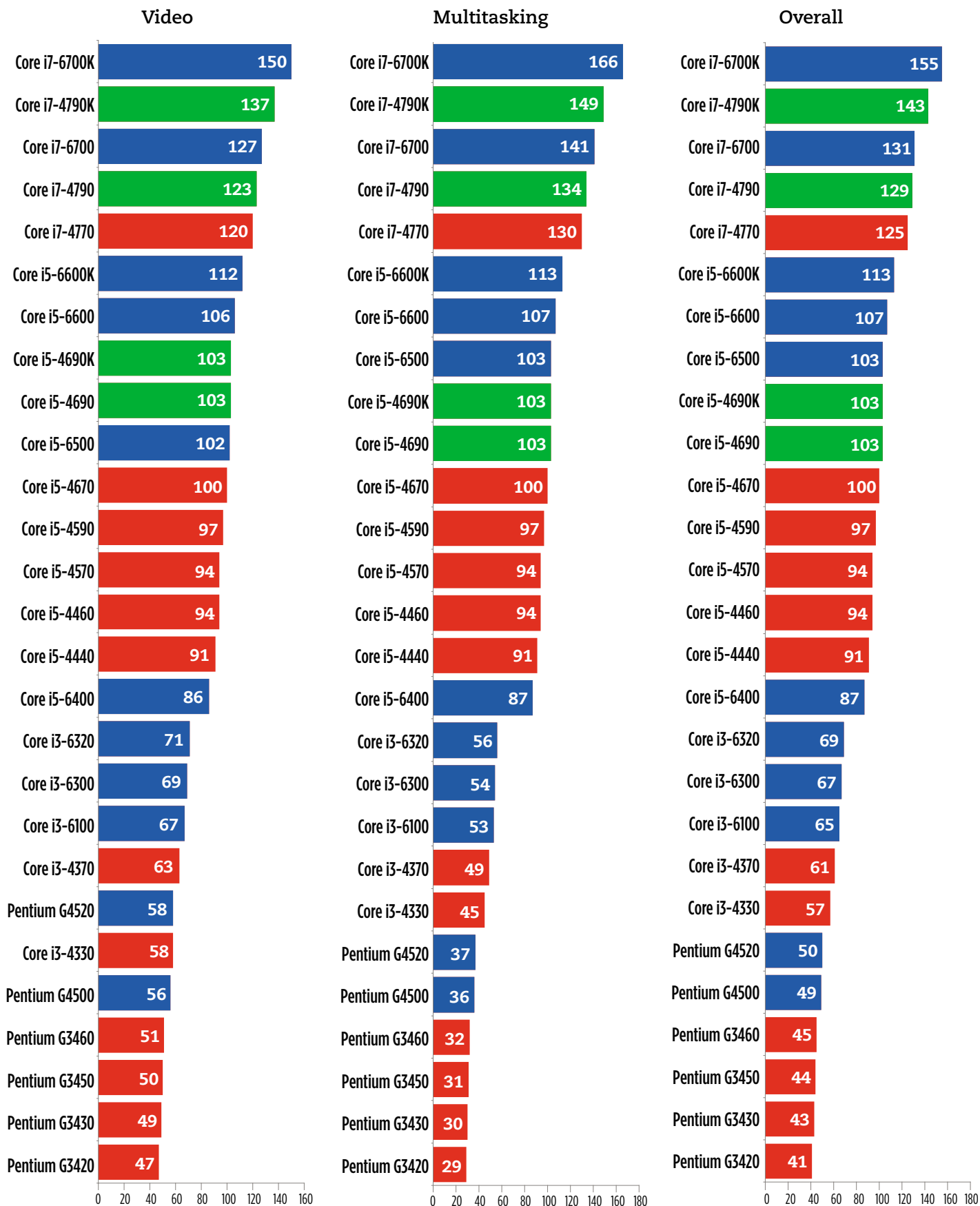
INTEL Benchmarks

2D Performance

Haswell

Devil's Canyon

Skylake



HASWELL									
	RECOMMENDED					RECOMMENDED			
	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL
	Pentium G3420	Pentium G3430	Pentium G3450	Pentium G3460	Core i3-4330	Core i3-4370	Core i5-4440	Core i5-4460	Core i5-4570
Rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Socket	LGA1150	LGA1150	LGA1150	LGA1150	LGA1150	LGA1150	LGA1150	LGA1150	LGA1150
Cores	Two	Two	Two	Two	Two plus two logical (Hyper-Threading)	Two plus two logical (Hyper-Threading)	Four	Four	Four
Frequency (Turbo)	3.2GHz (N/A)	3.3GHz (N/A)	3.4GHz (N/A)	3.5GHz (N/A)	3.5GHz (N/A)	3.8GHz (N/A)	3.1GHz (3.3GHz)	3.2GHz (3.4GHz)	3.2GHz (3.6GHz)
Multiplier	X32	X33	X34	X35	X35	X38	X31	X32	X32
External bus	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz
Process	22nm	22nm	22nm	22nm	22nm	22nm	22nm	22nm	22nm
Level 1 cache	2x 64KB	2x 64KB	2x 64KB	2x 64KB	2x 64KB	2x 64KB	4x 64KB	4x 64KB	4x 64KB
Level 2 cache	2x 256KB	2x 256KB	2x 256KB	2x 256KB	2x 256KB	2x 256KB	4x 256KB	4x 256KB	4x 256KB
Level 3 cache	3MB	3MB	3MB	3MB	3MB	3MB	6MB	6MB	6MB
Supported memory type	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3
Power rating (TDP)	53W	53W	53W	53W	54W	54W	84W	84W	84W
Integrated graphics	HD Graphics	HD Graphics	HD Graphics	HD Graphics	HD Graphics 4600	HD Graphics 4600	HD Graphics 4600	HD Graphics 4600	HD Graphics 4600
Price including VAT	£54	£70	£66	£68	£116	£116	£148	£143	£159
Supplier	www.ebuyer.com	www.cclonline.com	www.ebuyer.com	www.dabs.com	www.dabs.com	www.scan.co.uk	www.ebuyer.com	www.scan.co.uk	www.ebuyer.com
Details	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com
Part code	BX80646G3420	BX80646G3430	BX80646G3450	BX80646G3460	BX80646I34330	BX80646I34370	BX80646I54440	BX80646I54460	BX80646I54570

DEVIL'S CANYON					SKYLAKE				
	BEST BUY				BEST BUY			RECOMMENDED	
	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL
	Core i5-4590	Core i5-4670	Core i7-4770	Core i5-4690	Core i5-4690K	Core i7-4790	Core i7-4790K	Pentium G4500	Pentium G4520
Rating	★★★★★	★★★★★	★★★★☆	★★★★☆	★★★★★	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Socket	LGA1150	LGA1150	LGA1150	LGA1150	LGA1150	LGA1150	LGA1150	LGA1151	LGA1151
Cores	Four	Four	Four plus four logical (Hyper-Threading)	Four	Four	Four plus four logical (Hyper-Threading)	Four plus four logical (Hyper-Threading)	Two	Two
Frequency (Turbo)	3.3GHz (3.7GHz)	3.4GHz (3.8GHz)	3.5GHz (3.9GHz)	3.5GHz (3.9GHz)	3.5GHz (3.9GHz)	3.6GHz (4GHz)	4GHz (4.4GHz)	3.5GHz (N/A)	3.6GHz (N/A)
Multiplier	X33	X34	X35	X35	X35	X36	X40	X35	X36
External bus	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz
Process	22nm	22nm	22nm	22nm	22nm	22nm	22nm	22nm	22nm
Level 1 cache	4x 64KB	4x 64KB	4x 64KB	4x 64KB	4x 64KB	4x 64KB	4x 64KB	2x 64KB	2x 64KB
Level 2 cache	4x 256KB	4x 256KB	4x 256KB	4x 256KB	4x 256KB	4x 256KB	4x 256KB	2x 256KB	2x 256KB
Level 3 cache	6MB	6MB	8MB	6MB	6MB	8MB	8MB	3MB	3MB
Supported memory type	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3	DDR4	DDR4
Power rating (TDP)	84W	84W	84W	84W	88W	84W	88W	47W	47W
Integrated graphics	HD Graphics 4600	HD Graphics 4600	HD Graphics 4600	HD Graphics 4600	HD Graphics 4600	HD Graphics 4600	HD Graphics 4600	HD Graphics 530	HD Graphics 530
Price including VAT	£156	£172	£243	£173	£189	£245	£269	£66	£74
Supplier	www.ebuyer.com	www.ebuyer.com	www.ebuyer.com	www.ebuyer.com	www.ebuyer.com	www.ebuyer.com	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk
Details	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com
Part code	BX80646I54590	BX80646I54670	BX80646I74770	BX80646I54690	BX80646I54690K	BX80646I74790	BX80646I74790K	BX80662G4500	BX80662G4520

	RECOMMENDED				RECOMMENDED		BEST BUY		BEST BUY	
	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL	INTEL
	Core i3-6100	Core i3-6300	Core i3-6320	Core i5-6400	Core i5-6500	Core i5-6600	Core i5-6600K	Core i7-6700	Core i7-6700K	Core i7-6700K
Rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★★	★★★★☆	★★★★★	★★★★☆	★★★★★	★★★★★
Socket	LGA1151	LGA1151	LGA1151	LGA1151	LGA1151	LGA1151	LGA1151	LGA1151	LGA1151	LGA1151
Cores	Two	Two	Two	Four	Four	Four	Four	Four	Four	Four
Frequency (Turbo)	3.7GHz (N/A)	3.8GHz (N/A)	3.9GHz (N/A)	2.7GHz (3.3GHz)	3.2GHz (3.6GHz)	3.3GHz (3.9GHz)	3.5GHz (3.9GHz)	3.4GHz (4GHz)	4GHz (4.2GHz)	4GHz (4.2GHz)
Multiplier	X37	X38	X39	X27	X32	x33	x35	x34	x40	x40
External bus	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz
Process	22nm	22nm	22nm	22nm	22nm	22nm	22nm	22nm	22nm	22nm
Level 1 cache	2x 64KB	2x 64KB	2x 64KB	4x 64KB	4x 64KB	4x 64KB	4x 64KB	4x 64KB	4x 64KB	4x 64KB
Level 2 cache	2x 256KB	2x 256KB	2x 256KB	4x 256KB	4x 256KB	4x 256KB	4x 256KB	4x 256KB	4x 256KB	4x 256KB
Level 3 cache	3MB	4MB	4MB	6MB	6MB	6MB	6MB	8MB	8MB	8MB
Supported memory type	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4
Power rating (TDP)	51W	51W	51W	65W	65W	65W	91W	65W	91W	91W
Integrated graphics	HD Graphics 530	HD Graphics 530	HD Graphics 530	HD Graphics 530	HD Graphics 530	HD Graphics 530	HD Graphics 530	HD Graphics 530	HD Graphics 530	HD Graphics 530
Price including VAT	£94	£117	£126	£147	£160	£177	£198	£263	£319	£319
Supplier	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk
Details	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com
Part code	BX80662I36100	BX80662I36300	BX80662I36320	BX80662I56400	BX80662I56500	BX80662I56600	BX80662I56600K	BX80662I76700	BX80662I76700K	BX80662I76700K

AMD Socket AM1

AMD'S AM1 PROCESSORS are designed for low-cost computers capable of simple tasks. Prices are low: the top-end Athlon 5350 costs less than £40, making it an enticing choice for those looking to build an everyday desktop PC. All the chips are incredibly frugal, rated at just 25W TDP – a fraction of the power required by the high-end AM3+ chip.

AMD has abandoned its usual cooler mount, creating a new one specifically for AM1. This is largely because the tiny chips don't need as much cooling, and the new design means it's possible to make smaller motherboards for smaller computers.

We're not impressed with the design, though. It uses just two clips diagonally opposite each other; they don't make the cooler feel as secure as Intel coolers do, which use four clips. The instructions don't help, either: don't try to push the entire assembly through the holes in the board; instead, push the clips in first, then the retaining pins. Fortunately, once in place the stock cooler is unobtrusive, small and its fan is very quiet.

You'll need a matching AM1 motherboard to go with the range. These are just as cheap as the processors, letting you build a very low-cost computer. See our motherboard guide on page 100 for more information.

AM1					
MODEL	FREQUENCY	CORES	RATING	PRICE	BENCHMARK SCORE
Sempron 2650	1.45GHz	Two	★★★★☆	£21	7
Sempron 3850	1.3GHz	Four	★★★★☆	£21	10
Athlon 5150	1.6GHz	Four	★★★★☆	£30	14
Athlon 5350	2.05GHz	Four	★★★★☆	£37	17

ARCHITECTURE AND PERFORMANCE

Currently only four processors use the AM1 socket. All four are part of AMD's Kabini family and use its Jaguar 28nm microarchitecture, and all have four cores apart from the cheapest Sempron 2650, which has two.

It's common with modern processors for each core to have its own L1 and L2 cache, helping boost performance by reducing the number of times a CPU has to access slow system RAM. Shared L3 cache sits on top of this, for when different cores have to access the same bit of memory. With the AM1 chips, there's no L3 cache and L2 cache is shared.

AMD uses comparatively low clock speeds for its chips: the fastest model, the Athlon 5350, has a clock speed of just 2.05GHz. This has a knock-on effect on performance, and the AM1 range is the slowest we've ever tested, particularly in our multitasking benchmarks. The chips cope well with simple, everyday tasks, but you wouldn't want to try anything too complicated with them.

ONBOARD GRAPHICS

AMD has integrated Radeon R3 graphics into the chips, which has 128 graphics cores. The two Athlon processors' graphics are clocked at 600MHz, while it runs at 450MHz on the Sempron 3850 and 400MHz on the 2650.

You'll need to keep your expectations in check. Both Sempron processors failed even to load Dirt Showdown, while the Athlon chips were too slow to play it at our usual 1,280x720 resolution with 4x AA and High quality settings. The chips also proved to be a bottleneck with our discrete graphics card. The integrated graphics on all chips are good enough for Full HD video, so these processors can be useful in a low-power media centre PC.

VERDICT

It's hard to recommend any of the processors here. They may be cheap, but they're very slow and feel like a false economy. Unless you want to build a very low-powered and quiet computer, the FM2+ range is a much better choice and not a lot more expensive.

AMD Socket AM3+

WHILE MOST OF AMD's range has built-in graphics chips, the AM3+ range doesn't have this capability. That's no bad thing if you're willing to buy a graphics card, as you get a lot of power here for decent money. You can pick up an AMD HD 5450 graphics card for around £20, so adding graphics isn't expensive.

ARCHITECTURE AND PERFORMANCE

AMD's FX-series use one or more modules, each of which has two cores and 2MB of level 2 cache. All the FX chips we tested have 8MB of L3 cache apart from the FX-4300, which has 4MB. The modular approach is intended to share cache more efficiently, providing a larger pool of L2 cache for each pair of cores.

Power requirements vary wildly across the FX series, from 95W to a staggering 220W for the latest FX-9000 series. In contrast, FM2+ processors currently top-out at 100W TDP.

All FX chips have unlocked multipliers, so a quick performance upgrade is potentially just a visit to the BIOS away. This is not without its risks, though; we recommend boosting the speed in small increments to ensure stability.

The FX series goes up to eight cores. You can identify how many cores an AM3+ chip has by the number in its name: the FX-4300 is

AM3+						
Model		Frequency (Turbo)	Cores	Rating	Price	Benchmark Score
FX-6300	COMPUTER SHOPPER RECOMMENDED	3.5GHz (4.1GHz)	Six	★★★★★	£81	73
FX-6350		3.9GHz (4.2GHz)	Six	★★★★☆	£99	75
FX-8320	COMPUTER SHOPPER BEST BUY	3.5GHz (4GHz)	Eight	★★★★☆	£114	85
FX-8320E		3.2GHz (4GHz)	Eight	★★★★☆	£101	83
FX-8350		4GHz (4.2GHz)	Eight	★★★★★	£137	98
FX-8370		4GHz (4.3GHz)	Eight	★★★★☆	£156	100
FX-9370		4.4GHz (4.7GHz)	Eight	★★★★☆	£161	109
FX-9590	COMPUTER SHOPPER BEST BUY	4.7GHz (5GHz)	Eight	★★★★★	£165	117

quad-core, FX-6350 is six-core and FX-8350 is eight-core. The only outliers are the newly released eight-core FX-9370 and FX-9590.

Windows applications increasingly take advantage of more than four cores, and our tough 4K benchmarks tax every core to its limit. If you're most interested in application performance, AM3+ processors provide far better performance than FM2/FM2+ CPUs.

Even the cheapest FX-6300 managed a score of 73 in our benchmarks, faster than even the quickest FM2+ socket processor. The number of cores makes a difference to performance, with the eight-core processors achieving by far the highest scores in our tests.

AMD FX chips use Turbo Core technology, which automatically increases the clock speed when there's enough thermal overhead.

Finally, models that have an 'E' in the name are low-power models, although they still have a 95W TDP rating, so aren't that efficient.

VERDICT

If you're prepared to add a graphics card, the AM3+ range gives you great performance for the money. The FX-9370 and FX-9590, unsurprisingly, provide the best performance. The eight-core FX-9590 gives you the best balance between performance and price, and it wins a Best Buy award.

Further down the scale, the FX-8350 is only a little slower, but this eight-core model is still quick and excellent value. It wins a Best Buy award. If you want a CPU for less than £100, it's hard to beat the FX-6300. This six-core processor wins a Recommended award.

AMD Socket FM2+

AMD'S A-SERIES processors are designed to offer all-round performance, with a high-quality CPU and GPU bundled together in one package. These processors consist of FM2+ models, with the older FM2 line discontinued. They're not as quick as the FX range in 2D tasks, but with high-quality graphics, they're brilliant all-rounders if you don't want to buy a dedicated graphics card. These chips are also competitively priced, letting you build a powerful system on a tight budget.

ARCHITECTURE AND PERFORMANCE

The latest generation of FM2+ processors, codenamed Kaveri, use AMD's Steamroller modules for the CPU and GCN 1.0 (Graphics Core Next) for the GPU. The most recent Kaveri processors we've reviewed here only work with an FM2+ motherboard.

Kaveri was preceded by Richland and Trinity-generation processors, both of which will work with either FM2 or FM2+ motherboards thanks to the backwards-compatible nature of FM2+ motherboards. However, these models aren't easily available and should be avoided. We've listed only full FM2+ processors in our table.

AMD has managed to shrink down its manufacturing process for the latest

FM2+							
MODEL		FREQUENCY (TURBO)	CORES	GRAPHICS SPEED	GRAPHICS CORES	RATING	PRICE
A6-7400K	COMPUTER SHOPPER BEST BUY	3.5GHz (3.9GHz)	Two	756MHz	256	★★★★★	£48
A8-7600		3.1GHz (3.8GHz)	Four	720MHz	384	★★★★☆	£67
A8-7670K		3.6GHz (3.9GHz)	Four	757MHz	384	★★★★☆	£84
A10-7700K	COMPUTER SHOPPER BEST BUY	3.4GHz (3.8GHz)	Four	720MHz	384	★★★★★	£92
A10-7800		3.5GHz (3.9GHz)	Four	720MHz	512	★★★★☆	£98
A10-7850K		3.7GHz (4GHz)	Four	720MHz	512	★★★★☆	£100
A10-7870K		3.9GHz (4.1GHz)	Four	866MHz	512	★★★★☆	£108

generation Kaveri processors to 28nm, down from 32nm in previous generations. This has helped keep the Thermal Design Power (TDP) rating to just 95W even on the quickest processors, meaning that they use less power and run cooler.

You can't tell from the model name how many cores a processor has, so you'll need to check our table on page 96 for the full details. AMD's FM2+ chips are all either dual- or quad-core models, though. Pairs of cores are installed as modules, sharing level 2 cache to speed up access to slow system memory, although the chips have no level 3 cache shared between all cores.

AMD has kept the TDP rating to just 95W even on the quickest processors, meaning they use less power and run cooler

As well as the standard clock speed, all these chips use AMD's Turbo Core technology to increase the clock speed automatically when there's enough thermal overhead. This helps boost performance. Finally, look out for the models with a 'K' suffix, as these have unlocked multipliers, so you can easily overclock them.

ONBOARD GRAPHICS

A-series processors include AMD's integrated graphics. On these chips, the onboard graphics are often fast enough to play modern games without the need for a discrete graphics card. The quality of the graphics chip depends on the processor.

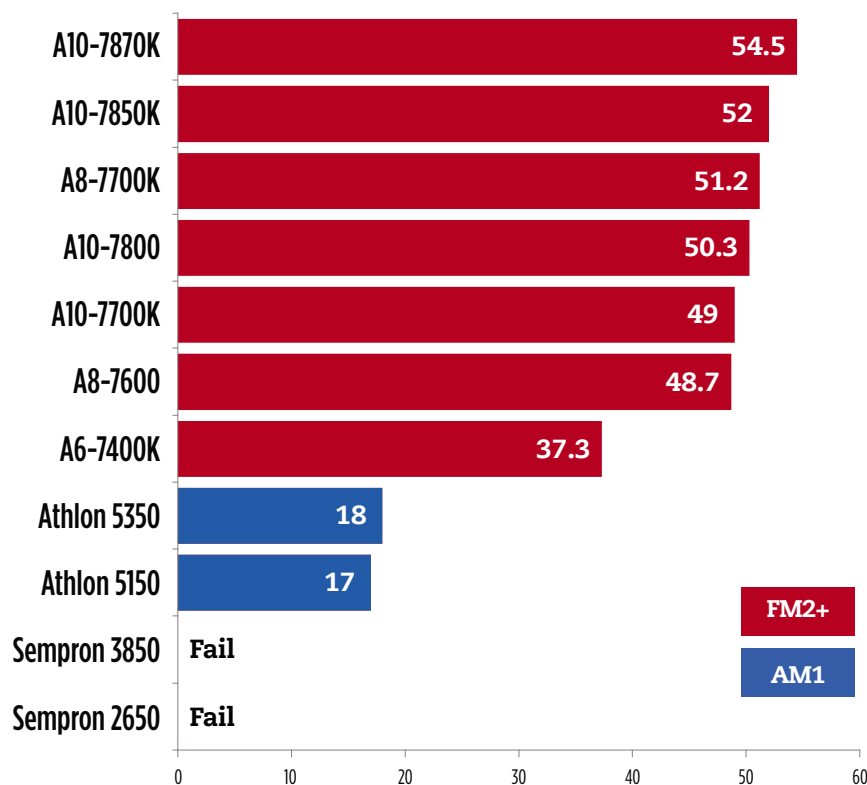
With FX chips AMD's naming convention tells you how many cores a chip has; with FM2+, there's no such luxury and the model name refers to how many graphics cores there are. For example, the A6 range has 256 cores. Within each model range, the graphics core can run at different speeds, so it's important to check the specs before you buy. Our graph on the left shows how well each chip performed in our graphics benchmarks.

VERDICT

While not as quick as FX processors in 2D tasks, the integrated graphics of FM2+ processors let you build a powerful all-in-one computer that can cope with light gaming.

If you want to build a cheap yet capable PC, the A6-7400K is an excellent choice and wins a Best Buy award. For a great balance between desktop and graphics performance, the A10-7700K is a brilliant all-rounder, and also wins a Best Buy award.

Dirt Showdown 1,280x720, High detail, 4x AA (fps)



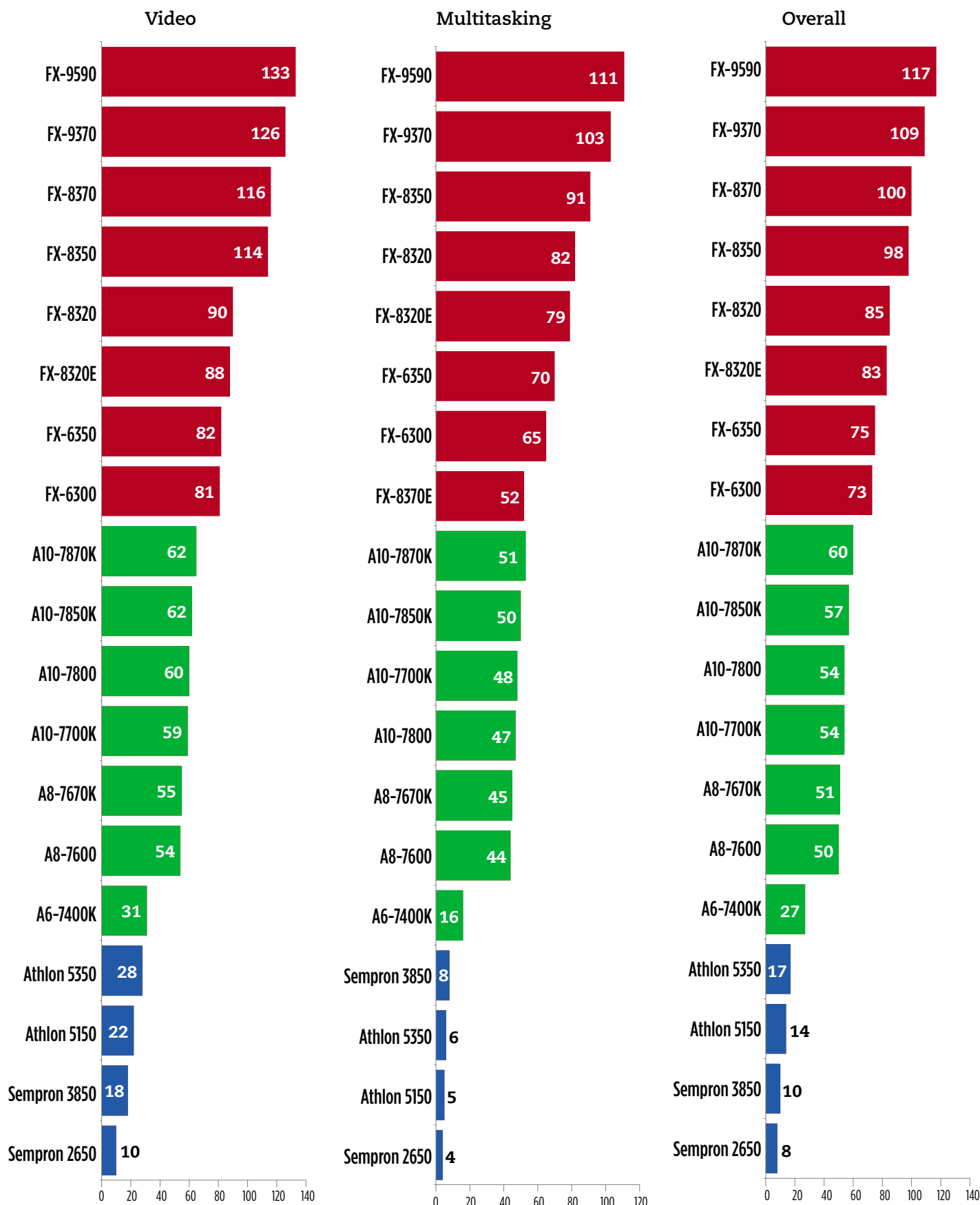
AMD Benchmarks

2D Performance

AM3+

FM2+

AM1



	SOCKET AM1				SOCKET AM3+	
	AMD	AMD	AMD	AMD	AMD	AMD
	Sempron 2650	Sempron 3850	Athlon 5150	Athlon 5350	FX-6300	FX-6350
Rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★★	★★★★☆
Socket	AM1	AM1	AM1	AM1	AM3+	AM3+
Cores	Two	Four	Four	Four	Six	Six
Frequency (Turbo)	1.45GHz (N/A)	1.3GHz (N/A)	1.6GHz (N/A)	2.05GHz (N/A)	3.5GHz (4.1GHz)	3.9GHz (4.2GHz)
Multiplier	x14.5	x13	x16	x20.5	17.5x	x19.5
External bus	100MHz	100MHz	100MHz	100MHz	200MHz	200MHz
Process	28nm	28nm	28nm	28nm	32nm	32nm
Level 1 cache	4x 32KB	4x 32KB	4x 32KB	4x 32KB	3x 64KB	3x 64KB
Level 2 cache	2MB	2MB	2MB	2MB	3x 2MB	3x 2MB
Level 3 cache	None	None	None	None	8MB	8MB
Supported memory type	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3
Power rating (TDP)	25W	25W	25W	25W	95W	125W
Integrated graphics	AMD Radeon R3	AMD Radeon R3	AMD Radeon R3	AMD Radeon R3	None	None
Price including VAT	£21	£21	£30	£37	£81	£99
Supplier	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk
Details	www.amd.com	www.amd.com	www.amd.com	www.amd.com	www.amd.com	www.amd.com
Part code	SD2650JAHMBOX	SD2650JAHMBOX	AD5150JAHMBOX	AD5350JAHMBOX	FD6300WMHKBOX	FD6350FRHKBOX

	BEST BUY		BEST BUY		BEST BUY	
	AMD	AMD	AMD	AMD	AMD	AMD
	FX-8320	FX-8320E	FX-8350	FX-8370	FX-9370	FX-9590
Rating	★★★★☆	★★★★☆	★★★★★	★★★★☆	★★★★☆	★★★★★
Socket	AM3+	AM3+	AM3+	AM3+	AM3+	AM3+
Cores	Eight	Eight	Eight	Eight	Eight	Eight
Frequency (Turbo)	3.5GHz (4GHz)	3.2GHz (4GHz)	4GHz (4.2GHz)	4GHz (4.3GHz)	4.4GHz (4.7GHz)	4.7GHz (5GHz)
Multiplier	x17.5	x16	x20	x20	x22	x23.5
External bus	200MHz	200MHz	200MHz	200MHz	200MHz	200MHz
Process	32nm	32nm	32nm	32nm	32nm	32nm
Level 1 cache	4x 64KB	4x 64KB	4x 64KB	4x 64KB	4x 64KB	4x 64KB
Level 2 cache	4x 2MB	4x 2MB	4x 2MB	4x 2MB	4x 2MB	4x 2MB
Level 3 cache	8MB	8MB	8MB	8MB	8MB	8MB
Supported memory type	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3
Power rating (TDP)	125W	95W	125W	95W	220W	220W
Integrated graphics	None	None	None	None	None	None
Price including VAT	£114	£101	£137	£156	£161	£165
Supplier	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.ebuyer.com	www.ebuyer.com
Details	www.amd.com	www.amd.com	www.amd.com	www.amd.com	www.amd.com	www.amd.com
Part code	FD8320FRHKBOX	FD8320EWMHKBOX	FD8350FRHKBOX	FD8370FRHKBOX	FD9370FHHKWOF	FD9590FHHKWOF

	SOCKET FM2+						
	BEST BUY		BEST BUY				
	AMD	AMD	AMD	AMD	AMD	AMD	AMD
	A6-7400K	A8-7600	A8-7670K	A10-7700K	A10-7800	A10-7850K	A10-7870K
Rating	★★★★★	★★★★☆	★★★★☆	★★★★★	★★★★☆	★★★★☆	★★★★☆
Socket	FM2+	FM2+	FM2+	FM2+	FM2+	FM2+	FM2+
Cores	Two	Four	Four	Four	Four	Four	Four
Frequency (Turbo)	3.5GHz (3.9GHz)	3.1GHz (3.8GHz)	3.6GHz (3.9GHz)	3.4GHz (3.8GHz)	3.5GHz (3.9GHz)	3.7GHz (4GHz)	3.9GHz (4.1GHz)
Multiplier	x35	x31	x36	x34	x35	x37	x37
External bus	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz	100MHz
Process	28nm	28nm	28nm	28nm	28nm	28nm	28nm
Level 1 cache	128KB	256KB	256KB	256KB	256KB	256KB	256KB
Level 2 cache	2x 512KB	2x 2MB	2x 2MB	2x 2MB	2x 2MB	2x 2MB	2x 2MB
Level 3 cache	None	None	None	None	None	None	None
Supported memory type	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3	DDR3
Power rating (TDP)	65W	65W	95W	95W	65W	95W	95W
Integrated graphics	AMD Radeon R5	AMD Radeon R7	AMD Radeon R7	AMD Radeon R7	AMD Radeon R7	AMD Radeon R7	AMD Radeon R7
Price including VAT	£48	£67	£84	£92	£98	£100	£108
Supplier	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk	www.scan.co.uk
Details	www.amd.com	www.amd.com	www.amd.com	www.amd.com	www.amd.com	www.amd.com	www.amd.com
Part code	AD740KYBJABOX	AD7600YBJABOX	AD767KXBJCBOX	AD770KXBJABOX	AD7800YBJABOX	AD785KXBJABOX	AD787KXDJCBOX

Prices correct at time of going to press



CASE STUDIES

PC cases

There's no point going to all the effort of building your own PC if you don't make it look nice, too. These cases will give you looks and performance

YOUR PC'S CASE is something you're going to see all the time, so it's important to make the right decision. The case also defines the type of motherboard you can fit, how big a graphics card you can buy and the number of peripherals you can connect. Build quality is also extremely important, as a well-made case will be quieter and keep your PC cooler.

This month we've looked at lots of cases, but rather than bring you reviews of the poor ones, we've ditched them. What's left are cases that are well made and durable, even the budget ones. With our help, you'll be able to select a case that matches your needs and budget.

LOOKING GOOD

You're going to be looking at your PC case every day, so you'll want to choose one that's easy on the eye and to your own taste. Cases

can come in all manner of shapes and sizes, which can mean the difference between the finished PC fitting inside a living room AV cabinet, on top of your desk or being so big it will need to sit on the floor.

Cases come in a variety of colours and materials as well as designs, and sometimes a particular model will have numerous colour options, making it easier to find one to your liking. A PC is a big item, so it makes sense to have one you like the look of. Build materials and finish are also important. Some cheaper cases aren't always well finished inside, meaning edges aren't rounded off and are potentially sharp, making working inside them uncomfortable. A good-quality PC case will be well finished, easy to work in, use quality materials such as steel rather than plastic, and also look great.

SIZE MATTERS

The actual physical size of a case isn't only important in terms of where you can put it, but it also affects what components you can fit inside. Motherboards come in different sizes and we've reviewed cases that support the standard ATX and the smaller microATX motherboard sizes, as well as more specialist sizes such as Mini-ITX. All ATX cases will also take microATX and Mini-ITX boards, but microATX cases can only fit microATX motherboards or smaller. All cases have multiple mounting points for all kinds of different sizes of motherboard, but you should always check the specifications before you buy.

The internal size of a case will also limit what graphics card or processor cooler you can install. In our reviews we note how much clearance you have for a graphics card, as well as how much space is left above the processor for a cooler. Some graphics cards are over 300mm long and some coolers are more than 160mm high, so if you're planning to fit some seriously high-specification kit, make sure your case will be big enough. A

**COOLER MASTER**

Cosmos SE

★★★★★

CORSAIR

Graphite 380T

★★★★★

BEST BUY**CORSAIR**

Carbide Series Air 240

★★★★★

HARDWARE

USB2 ports	2	0	0
USB3 ports	2	2	2
Case type	ATX	Mini-ITX	MicroATX
Motherboard compatibility	ATX, microATX, Mini-ITX	Mini-ITX	MicroATX, Mini-ITX
Fan mounts	3x 120/140mm, 4x 120mm	2x 120mm, 1x 140/200mm	2x 80mm, 7x120mm
Supplied fans	1x 140mm, 3x 120mm	1x 140mm, 1x 120mm	3x120mm
Max 2½in drive bays	18	2	3
Max 3½in drive bays	8	2	3
Max 5½in drive bays	3	0	0
Max graphics card length	276mm with HDD bracket, 395mm without	290mm	290mm
Dimensions	569x264x524mm	356x292x393mm	320x260x397mm
Weight	10.8kg	5.5kg	5.6kg

BUYING INFORMATION

Price including VAT	£150	£75	£78
Warranty	Two years RTB	Two years RTB	Two years RTB
Supplier	www.ebuyer.com	www.scan.co.uk	www.cclonline.com
Details	www.cooler-master.com	www.corsair.com	www.corsair.com
Part code	COS-5000-KWN1	CC-9011060-WW	CC-9011070-WW
Verdict	If you're building a beast of a computer, this is the case for you. It's huge, but that means there's plenty of room inside for everything that you could ever possibly want to fit.	This mini and portable case is perfect if you're planning on building a Mini-ITX PC. There's not a lot of room inside, but the PC will look fantastic when you've finished building it.	This microATX case is extremely well made. It's compact, but its cuboid design means there's plenty of room inside for all your components. It's a great mid-range case and wins a Best Buy award.

large, spacious interior will also be better for airflow, helping to keep your components cool and running efficiently.

DRIVING FORCE

Optical disc drives are increasingly less important in computing, so many PC cases no longer have external 5¼in drive bays. If you're planning on installing software from disc or watching DVDs or Blu-rays on your system, make sure you buy a case with external drive bays so you don't have to rely on a messy external USB drive.

We mention how many external drive bays each case has and how they are configured in the reviews and in the table

above. Some drive bays can also be removed if you don't need them, freeing up space for bigger graphics cards and improving airflow. Again, the table above explains all.

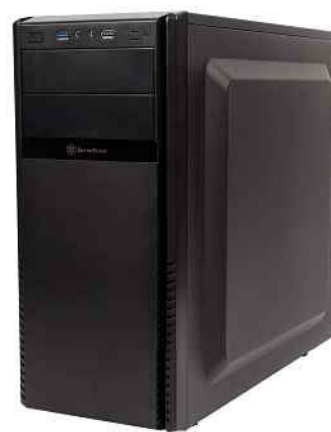
COOL BREEZE

All the components you fit inside your system will generate heat, whether it's the processor, motherboard, graphics card or hard disks. It's dangerous for the internal temperature in your case to reach high levels, as this can damage the sensitive components inside or cause them to throttle performance in order to keep temperatures under control. This is why it's important to consider how well a case is designed for cooling.

Typically a case comes with at least two fans: one installed in the front of the case as an air intake, and another in the rear as an exhaust. This way fresh air is drawn into the system and across your components, removing the built-up heat and expelling it through the back of the case.

Most cases have mounting points for additional fans if you need extra cooling, and many also support radiators for very-high-performance liquid cooling systems.

The size of fan is also important. A large 200mm fan will be able to move more air while spinning more slowly than a small 80mm fan. This means it can do the same cooling job while making much less noise.



	RECOMMENDED	RECOMMENDED
NZXT	NZXT	SILVERSTONE
Source 340	Phantom 530	Quiet Precision PS11
★★★★☆	★★★★☆	★★★★★
0	0	0
2	2	2
ATX	ATX	ATX
ATX, microATX, Mini-ITX	ATX, microATX, Mini-ITX	ATX, microATX
3x 120/140mm, 1x 120mm	1x 200mm, 2x 140mm, 2x 120mm, 2x 200/140mm	2x 120mm, 2x 120/140mm
2x 120mm	1x 140mm, 1x 140mm	1x 120mm
2	6	2
3	6	3
0	3	2
334mm	310mm with HDD bracket, 444mm without	400mm
445x200x432mm	572x235x543	482x215x427mm
7.1kg	10.5kg	4.8kg
£59	£104	£35
Two years RTB	Two years RTB	One year RTB
www.ebuyer.com	www.kikatek.com	www.scan.co.uk
www.nzxt.com	www.nzxt.com	www.silverstonetek.com
CA-S340W-B1	CA-PH530-W1	SST-PS11B-Q
This case is a great all-rounder: it's well made, it has a decent amount of room inside and it looks neat, too. Its problem is that you can get cases that are just as well made for less, or better-looking ones for a little more.	If you want a case to show off your powerful new computer, the Phantom 530 strikes the right balance. It's neat, is available in white, black or red, and the side window lets you look in at your tidy build. It's a great mid- to high-end option.	Building a budget computer? This is the perfect case for you. Although it's cheap, it's surprisingly well made and there's plenty of room inside for all your components. The only real downside is that it looks a little plain.

Prices correct at time of going to press

ROUTE MASTER

The fans alone can't deal with all the build-up of heat if your system's airflow is poor. This is why proper cable routing is an important part of a system build. Without adequate routing, airflow can be blocked by the various cables strewn around your case, meaning the hot air can't be moved efficiently out of the system. This also means fans have to work harder and spin faster, creating yet more noise.

Many cases come with large viewing windows, so you can see the components inside. However, there's nothing worse than a large window showing off a rat's nest of cabling. A good case will often route the cables out of the way behind the

motherboard and provide cable ties and ready-cut holes to help you create a neat and attractive build. All the models we've featured this month have efficient cable routing.

PORT AUTHORITY

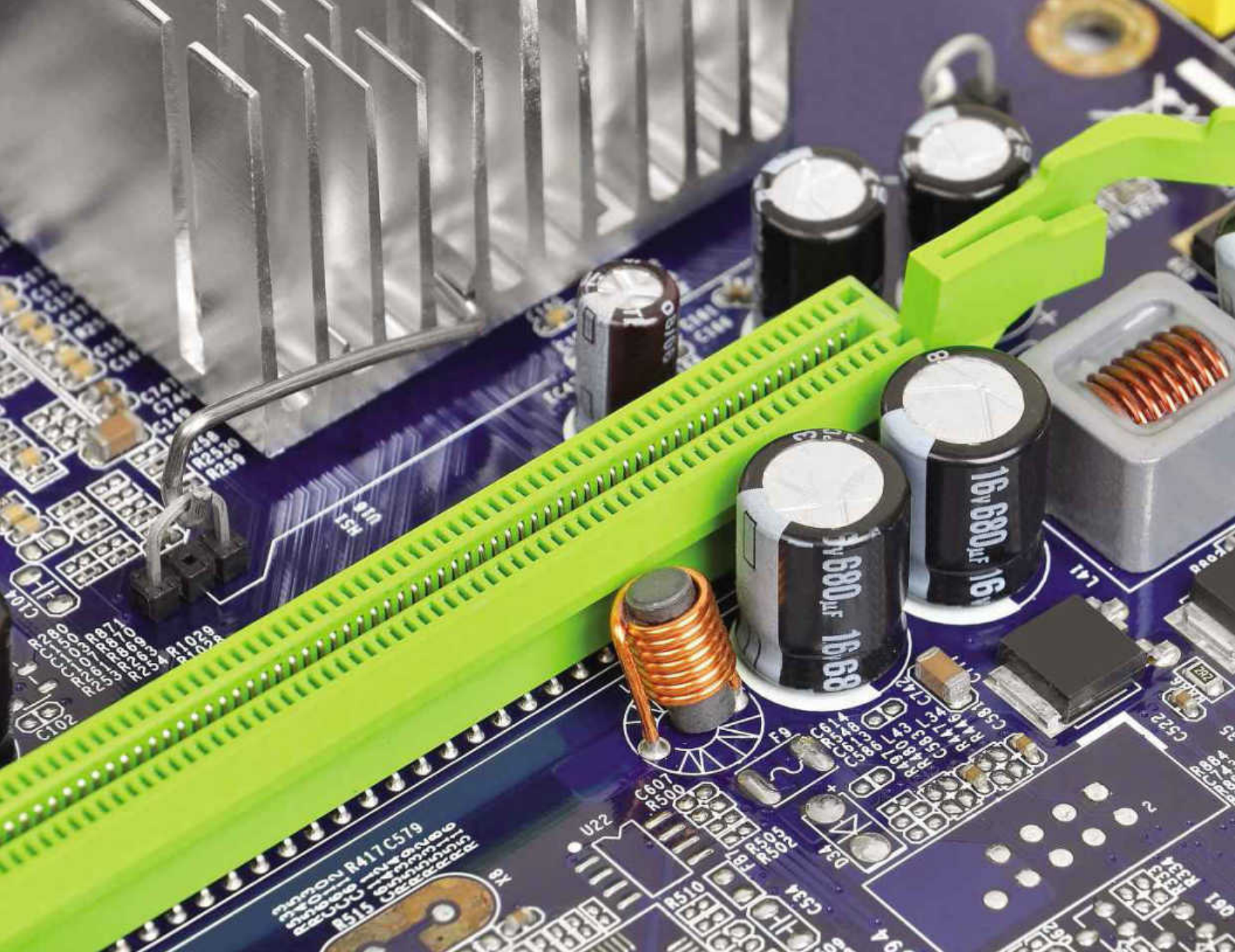
Having front- or top-mounted ports for connecting your peripherals, such as USB flash drives, is far more convenient than having to reach round and fumble behind your system. Most cases have front USB ports, and all the cases in this month's issue have faster USB3 sockets. These have to be connected to the relevant headers on your motherboard, so you'll need to make sure your board has the necessary headers

available. Every case here also has a front- or top-mounted headphone and microphone jack for connecting audio peripherals.

POWER PLAY

None of the cases we've reviewed comes with a power supply unit (PSU). This is arguably a good thing, as in our experience many cheap bundled PSUs have poor efficiency and can't deliver their rated wattage.

It's important to pick a PSU with adequate power for your components; a modular PSU, where unneeded cables can be detached, is also a good idea for efficient airflow and general neatness. For our recommended PSUs, see page 114.



ABOVE BOARD

Motherboards

Choosing the right motherboard can be hard, but our complete guide will help you make the right choice for any type of system

ONCE YOU'VE CHOSEN the type of processor you want, the next big choice to make is the motherboard in which to install it. Get the choice right and you'll be able to connect all the devices you want for years to come; get it wrong and you'll have a sub-standard build. Fortunately, we're here to help with our complete buying guide and our top recommendations.

Again, we're doing things a bit differently this year. The range of processors available, and the different types of boards they require, makes it hard to fit all the reviews into this magazine. Instead, we've tested new models

and been through our archive of previously reviewed products to find the top choices at a range of different price points. This year, we're not printing any of the benchmark scores: all motherboards of a set type use the same chipsets, so performance only varies by a percentage point or two: in other words, it's the processor that makes the difference, not the motherboard.

What's really important is making sure that your chosen model has all the features you'll need. Our tables on pages 102-105 list everything, so you can make the right decision. Here's what else to look out for.

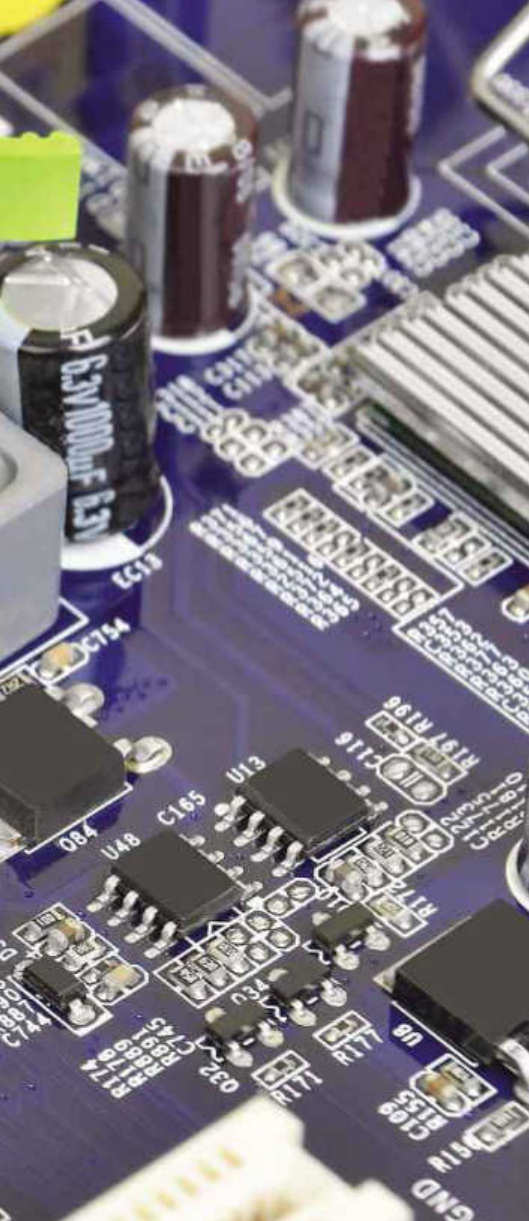
MEMORY TEST

DDR3 has been the standard type of memory used by all processors for some time, and that's still largely true today. However, if you're planning on using one of the latest Intel Skylake processors in your system, you'll need DDR4 memory instead.

In all cases, it's important to check that your motherboard has support for the maximum amount of RAM that you want to install. A board with four RAM slots will give you more flexibility in terms of RAM configuration and capacity than a board with just two slots. In addition, if you opt for a four-slot board now, you'll most likely have room for expansion in the future, too.

Most motherboards support dual-channel memory, where you eke a little more speed out of your RAM when you use two or four sticks of memory. You'll need to consult your motherboard's manual to ensure that you're using the right slots.

Finally, check the maximum speed of RAM that your motherboard supports. By default, your RAM will run at a lower speed until you go into the BIOS and enable either XMP (eXtreme Memory Profile, for Intel boards) or AMP (AMD Memory Profile).



NEED TO KNOW Intel processors

SOCKETS

Intel's current sockets are LGA1150 (for Haswell and Devil's Canyon chips) and LGA1151 (Skylake). You need to match the processor you buy with the type of motherboard you buy, as the two sockets aren't compatible with each other.

To make things more complicated, Intel's product ranges are all called Celeron, Pentium, Core i3, Core i5 and Core i7, regardless of the socket used. If in doubt, you can use ark.intel.com to look up the exact specifications of your processor to make sure that you're buying the right type of motherboard.

CHIPSETS

There are other caveats with Intel CPUs. Skylake requires any current LGA1151 motherboard using the Z170 chipset, with H170 motherboards coming soon. LGA1150 processors are a little more complicated. For Devil's Canyon, you generally need a board with an H97 or Z97 chipset; older LGA1150 boards may not work, so check the specs carefully. With Haswell chips you can use H97 and Z97, but can also buy older Z87 and H81 motherboards as well. These can be a bit cheaper. All the LGA1150 motherboards we've listed here support all the processors on pages 89-90.

NEED TO KNOW AMD processors

SOCKETS

Of the AMD processors that we reviewed, there are three types of socket, each incompatible with the others. They are AM3+, FM2+ and AM1. Fortunately, compatibility is easy to work out.

With an FM2+ motherboard, you can fit any existing FM2+ processor, but you can also fit older FM2 processors if you have one of those. In a similar way, AM3+ motherboards will take AM3+ FX processors, but you can also fit an older AM3 processor, should you have one you want to use.

Finally, AM1 is very simple as there's just the one set of processors to choose from.

Its advantage is that the motherboards and processors are extremely cheap.

CHIPSETS

FM2+ has a range of chipsets available for it, starting with the cheapest A58 boards (AMD recommends A4 and A6 processors are used with this); moving up, there's the A68H (A4 and A6 recommended); above this sits the A78 (A6 and A8) and the A88X (A8 and A10). The top-end A88X isn't that expensive, so check prices before you buy.

AM3+ chips have four 9-series chipsets available: 970, 980G, 990X and 990FX. We think 970 boards strike the best balance between value and performance.

CLOCKING ON

Most motherboards let you adjust the clock speeds and voltages of the CPU and RAM to push them further. This should be done with caution, as pushing components too far can cause damage. While we haven't gone into overclocking in detail here, our tables state if overclocking is possible with a motherboard.

SIZE MATTERS

All the boards here fit into two form factors: ATX and microATX. ATX boards are larger, giving you more expansion slots and a bit more room to work on; microATX boards are smaller and generally a little cheaper. Make sure you buy a board that matches your case: an ATX motherboard needs an ATX case, as it will not fit in a microATX case; a microATX motherboard will fit into both case sizes.

STORAGE

All your storage, from hard disks and SSDs to optical drives, needs to be connected to the motherboard via SATA cables. Look for SATA3 ports (sometimes called SATA 6GB/s), as these let you get the most from an SSD.

Some motherboards have an M.2 port, which lets you plug a small M.2 SSD directly

into the motherboard. As well as saving space, M.2 is faster than SATA. Some boards have SATA Express ports for new PCI-Express-based SSDs. All these may be useful if you're building a super-fast top-of-the-range system, but the performance of SATA3 with a regular SSD is good enough for most people.

Mechanical hard disks and optical drives don't benefit from the faster SATA standard, so you can connect them to older SATA2 ports, if available (they will also work with SATA3 if that's all that's available).

EXPRESS YOURSELF

PCI Express slots are the most common for expansion. The larger x16 slots are for graphics cards. Confusingly, not all x16 slots run at x16 speeds; it's common for one to run at x4 or x8 speed. Always use the fastest-rated slot for your main graphics card; the slower slots are for running multiple graphics cards via Nvidia SLI or AMD CrossFire.

You'll also find x1 slots and, potentially, some x4 slots for other expansion cards, such as a Wi-Fi card. Smaller cards can be plugged into bigger slots if you're struggling for room. Finally, if you want to run some legacy cards, look out for PCI slots.

GRAPHICS OUTPUTS

If your CPU has integrated graphics, look for a motherboard that has the graphics outputs you'll need. It's common to find a motherboard that has HDMI, DVI and VGA outputs; HDMI can be converted to DVI (and vice versa) using cheap adaptors if you want to run multiple monitors.

SOUNDING OFF

All motherboards have audio outputs through 3.5mm jacks, optical audio (S/PDIF) or HDMI. If your board has only three 3.5mm jacks, you can output to 5.1 surround sound systems, but you can't connect an input, such as a microphone, at the same time. The alternative is a motherboard with six 3.5mm jacks, or you can use a digital S/PDIF or HDMI output.

PLUG AND PLAY

All motherboards have USB connectors on the back and have headers to connect the extra ports on your case. USB3 ports are faster, but USB2 ports are fine for simple devices, such as keyboards and mice. We prefer having lots of USB3 headers, as it makes it easier to connect up USB3 ports at the front of your case for fast external

INTEL MOTHERBOARDS

LGA1151

**ASROCK**

Fatal1ty Z170 Gaming K4

★★★★☆

BEST BUY**ASUS**

Z170-A

★★★★★

RECOMMENDED**MSI**

Z170A Gaming M5

★★★★☆

HARDWARE

Processor socket	LGA1151	LGA1151	LGA1151
Form factor	ATX	ATX	ATX
Chipset	Z170	Z170	Z170
Supported memory type	DDR4 (3,866MHz)	DDR4 (3,400MHz)	DDR4 (3,600MHz)
Memory slots	4	4	4
Maximum memory	64GB	64GB	64GB
Motherboard power connectors	1x 24-pin ATX, 1x 8-pin 12V	1x 24-pin ATX, 1x 8-pin 12V	1x 24-pin ATX, 1x 8-pin 12V
PCI-E slots	2x PCI-E x16 (one at x16 speed, one at x4 speed), 3x PCI-E x1	2x PCI-E x16 (x16 speed or dual x8), 1x PCI-E x16 (x4 speed), 3x PCI-E x1, 1x PCI	2x PCI-E x16 (x16 speed or dual x8), 1x PCI-E x16 (x4 speed), 4x PCI-E x1
Motherboard fan headers	6	7	5
SATA ports	6x SATA3, 2x SATA Express, 1x M.2	6x SATA3, 1x SATA Express, 1x M.2	6x SATA3, 2x SATA Express, 2x M.2
Wired network ports	1x Gigabit	1x Gigabit	1x Gigabit
Motherboard sound (ports)	Realtek HD Audio (5x 3.5mm analogue, optical S/PDIF)	Realtek HD Audio (5x 3.5mm analogue, optical S/PDIF)	Realtek HD Audio (5x 3.5mm analogue, optical S/PDIF)
USB ports	2x USB2, 5x USB3, 1x USB3 Type-C	2x USB2, 4x USB3	2x USB2, 6x USB3
USB headers	2x USB2, 1x USB3	2x USB2, 2x USB3	2x USB2, 1x USB3
Video outputs	DVI, HDMI	DVI, VGA, HDMI, DisplayPort	DVI, HDMI
Other ports	1x PS/2	1x PS/2	1x PS/2

BUYING INFORMATION

Price including VAT	£107	£116	£133
Warranty	One year RTB	One year RTB	One year RTB
Supplier	www.ebuyer.com	www.scan.co.uk	www.ebuyer.com
Details	www.asrock.com	www.asus.com	www.msi.com
Part code	Z170 Gaming K4/D3	Z170-A	Z170A Gaming M5

VERDICT

There aren't really any budget Skylake motherboards, but this one is as close as you can get. Plenty of expansion options and loads of USB ports are great, but the second PCI-E x16 slot runs at only x4 speed.

This motherboard has practically everything, including lots of expansion options, a legacy PCI slot (which is a rarity) and a total of six USB3 ports. For most people building a Skylake PC, this is the board to buy.

This motherboard is a great choice for anyone who wants to use the latest technology: two M.2 slots and two SATA Express slots are great for future storage needs. However, you pay a chunk more for the privilege and you can get a similar range of features for less.

LGA1150



RECOMMENDED

ASROCK

Z97 Extreme6

★★★★★

BEST BUY

ASROCK

H97M Pro4

★★★★★

MSI

H81M-E34

★★★★☆

LGA1150

ATX

Z97

DDR3 (3,200MHz OC)

4

32GB

1x 24-pin ATX, 1x 8-pin 12V

2x PCI-E x16, 1x PCI-E x16 (x4 speed), 2x PCI-E x1

6

10x SATA3 (two operate as SATA Express), 1x M.2

2x Gigabit

Realtek HD Audio (6x 3.5mm analogue, optical S/PDIF)

6x USB3

4x USB2, 4x USB3

DVI, HDMI, DisplayPort

1x PS/2

£134

One year RTB

www.ebuyer.com

www.asrock.com

90-MXGTE0-A0UAY1Z

LGA1150

MicroATX

H97

DDR3 (1,600MHz)

4

32GB

1x 24-pin ATX, 1x 8-pin 12V

2x PCI-E x16 (one runs at x4 speed), 2x PCI

5

6x SATA3

1x Gigabit

Realtek HD Audio (5x 3.5mm analogue)

2x USB2, 4x USB3

2x USB2, 1x USB3

DVI, VGA, HDMI

1x PS/2

£71

One year RTB

www.cclonline.com

www.asrock.com

90-MXGTA0-A0UAYZ

LGA1150

MicroATX

H81 Express

DDR3 (1,600MHz)

2

16GB

1x 24-pin ATX, 1x 4-pin 12V

1x PCI-E x16, 2x PCI-E x1

3

2x SATA3, 2x SATA2

1x Gigabit

Realtek HD Audio (3x 3.5mm analogue)

2x USB2, 4x USB3

1x USB2, 2x USB3

DVI, VGA, HDMI

None

£45

One year RTB

www.box.co.uk

www.msi.com


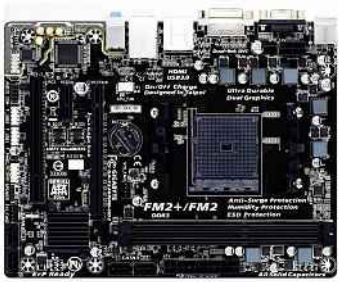

H81M-E34

If you want to build a powerful LGA1150 system, this is the motherboard for you. It's got lots of expansion options and an M.2 interface for super-fast SSD storage. The downside is that you pay a hefty premium for these features; if you don't need them, you can save around £60 on a cheaper board.

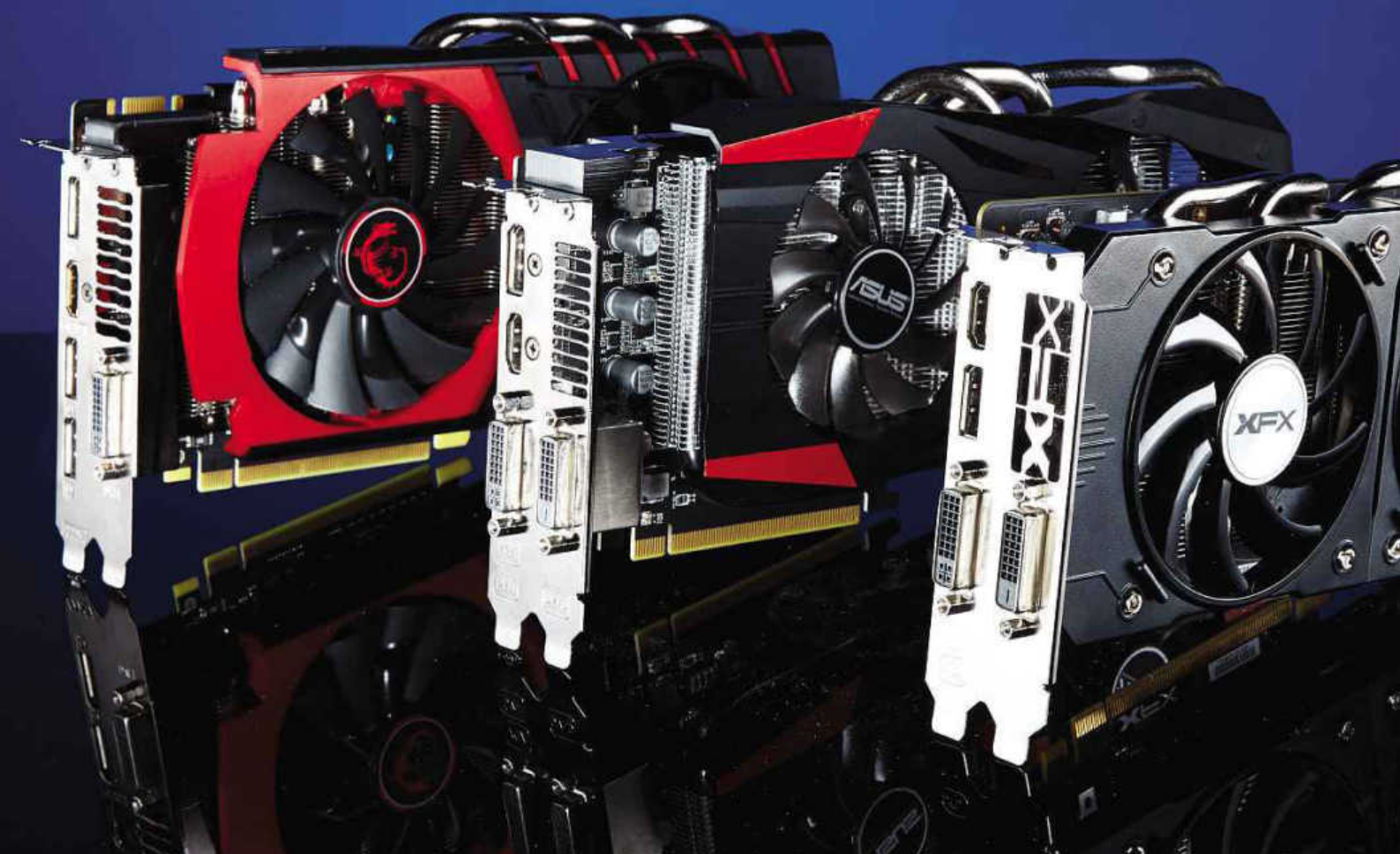
For a mid-range LGA1150 build, this motherboard is hard to beat. It's got all the sockets and ports you could need and supports the full range of Haswell and Devil's Canyon processors. The second PCI-E x16 slot runs at only x4 speed, but is useful for other expansion cards, rather than a second graphics card.

This motherboard is a little light on expansion and features, but it supports all LGA1150 processors, including Devil's Canyon models. If you want a small and cheap motherboard for a new PC, then it's a great buy.

AMD MOTHERBOARDS

	AM1	FM2+	
			
	RECOMMENDED	RECOMMENDED	
	MSI	GIGABYTE	GIGABYTE
	AM1M	GA-F2A68HM-HD2	GA-F2A88XN-WIFI
	★★★★☆	★★★★☆	★★★★☆
Hardware			
Processor socket	AM1	FM2+	FM2+
Form factor	MicroATX	MicroATX	Mini-ITX
Chipset	AM1	A68H	A88X
Supported memory type	DDR3 (1,600MHz)	DDR3 (2,133MHz)	DDR3 (2,133MHz)
Memory slots	2	2	2
Maximum memory	32GB	64GB	64GB
Motherboard power connectors	1x 24-pin ATX, 1x 4-pin 12V	1x 24-pin ATX, 1x 8-pin 12V	1x 24-pin ATX, 1x 4-pin 12V
PCI-E slots	1x PCI-E x16, 1x PCI-E x1	1x PCI-E x16, 1x PCI-E x1, 1x PCI	1x PCI-E x16
Motherboard fan headers	3	3	2
SATA ports	2x SATA3	4x SATA3	4x SATA3
Wired network ports	1x Gigabit	1x Gigabit	1x Gigabit
Motherboard sound (ports)	Realtek HD Audio (3x 3.5mm analogue)	Realtek HD Audio (3x 3.5mm analogue)	Realtek HD Audio (5x 3.5mm analogue, optical S/PDIF)
USB ports	4x USB2, 2x USB3	4x USB2, 2x USB3	4x USB2, 2x USB3
USB headers	4x USB2, 2x USB3	4x USB2	2x USB2, 2x USB3
Video outputs	DVI, VGA, HDMI	DVI, VGA, HDMI	DVI, 2x HDMI
Other ports	2x PS/2	1x PS/2	Mini PCI-E (801.11ac Wi-Fi)
Buying information			
Price including VAT	£25	£42	£84
Warranty	One year RTB	One year RTB	One year RTB
Supplier	www.ebuyer.com	www.ebuyer.com	www.ebuyer.com
Details	www.msi.com	www.gigabyte.com	www.gigabyte.com
Part code	911-7865-005	GA-F2A68HM-HD2	GA-F2A88XN-WIFI
Verdict			
	AM1 hasn't taken over the world and there aren't a lot of motherboards, but this MSI model is comparatively cheap and has all the expansion options you need for a good budget computer.	If you're looking to build a budget FM2+ computer, this is the motherboard to buy. It's excellent value and has lots of expansion options. The downside is that there's no USB3 header.	If you want to build a very small PC, this Mini-ITX board could be just what you're looking for. It's rather compact, but there are plenty of USB ports and headers, and you get built-in Wi-Fi, too.

AM3+		
		
BEST BUY	BEST BUY	
ASUS	MSI	GIGABYTE
A88XM-Plus	970A-G43	GA-990FXA-UD3
★★★★★	★★★★★	★★★★☆
FM2+	AM3+	AM3+
MicroATX	ATX	ATX
A88X	970	990FX
DDR3 (2,133MHz)	DDR3 (2,133MHz)	DDR3 (2,133MHz)
4	4	4
64GB	32GB	32GB
1x 24-pin ATX, 1x 4-pin 12V	1x 24-pin ATX, 1x 8-pin 12V	1x 24-pin ATX, 1x 8-pin 12V
2x PCI-E x16 (one runs at x4), 1x PCI- x1, 1x PCI	2x PCI-E x16 (one runs at x4), 2x PCI-E x1, 2x PCI	4x PCI-E x16 (two at x16, two at x4), 2x PCI-E x1, 1x PCI
3	3	4
8x SATA3	6x SATA3	6x SATA3
1x Gigabit	1x Gigabit	1x Gigabit
Realtek HD Audio (3x 3.5mm analogue)	Realtek HD Audio (6x 3.5mm analogue, optical S/PDIF)	Realtek HD Audio (6x 3.5mm analogue, optical S/PDIF)
4x USB2, 2x USB3	8x USB2, 2x USB3	8x USB2, 2x USB3
6x USB2, 2x USB3	6x USB2, 2x USB3	6x USB2, 2x USB3
DVI, VGA, HDMI	None	None
2x PS/2	1x PS/2	1x PS/2
£60	£51	£109
One year RTB	One year RTB	One year RTB
www.dabs.com	www.box.co.uk	www.amazon.co.uk
www.asus.com	www.msi.com	www.gigabyte.com
A88XM-Plus	970A-G43	GA-990FXA-UD3
For most people building with FM2+, this is the motherboard to buy. It's well-specified, has plenty of expansion options and is excellent value. A slower second PCI-E x16 slot may put off gamers.	If you're looking for value in your AM3+ build, look no further. With lots of expansion options and plenty of USB ports, this motherboard ticks all of the right boxes. Look out for the second PCI-E x16 slot, which runs at only x4 speed, though.	If you want a powerful AM3+ system, this is the right motherboard for you. It's got lots of expansion slots, including two full-speed PCI-E x16 slots. The big downside is the price, with non-gamers able to buy a motherboard for a lot less.



CONTAINS GRAPHIC SCENES

Graphics cards

If you want to turn your new computer into a powerful games machine, you'll need a graphics card that's capable of displaying the latest titles in their full glory. Here's what to look out for

ALTHOUGH MOST PROCESSORS now have graphic chips built in, the simple fact is that they're not good enough to cope with today's graphically intense games: they're designed for light gaming and for powering video and 2D displays. If you want more graphical prowess from your PC, you'll need a dedicated graphics card.

The big issue is that there are lots of different models to choose from, with manufacturers seemingly filling in every price point gap. It really isn't helpful and makes choosing the right model very difficult. This month, we've benchmarked every major

graphics chip to work out the best high-end, mid-range and entry-level cards. Over the page, you can see our test results and our in-depth table with recommendations, so you know which card to buy for your budget and needs. Before we dive into that, though, here's everything that you need to know.

CARDS ON THE TABLE

Although graphics cards are manufactured by third-party vendors, such as Sapphire and Asus, the actual graphics chips are made by Nvidia and AMD. Each third-party manufacturer is free to make some

adjustments to the card, such as overclocking it, but it rarely makes a big difference. Instead, you're best off choosing the type and model of the graphics chip, such as an AMD Radeon R8 370, and then finding the best deal on that card. This means that the real choice is one between Nvidia and AMD.

TEAM GREEN

Nvidia typically aims its cards at the high end, with few mid-range or entry-level cards available. If you demand the peak of performance from the most efficient cards, then Nvidia is your friend.

All Nvidia cards support the PhysX hardware-accelerated physics technology, although few games actually support it, as AMD can't use the technology. As a result, games developers won't implement an exclusive technology.

Multi-Frame Sampled Anti-Aliasing (MFAA) uses an Nvidia card's hardware to provide high-quality anti-aliasing, smoothing off jagged edges in games without a big performance hit (see box, right). Dynamic Super-Resolution (DSR) renders games at a higher resolution than your monitor can support, before scaling the graphics down, in effect adding support for Super Sampling Anti-Aliasing (SSAA, see box) in all games. This improves the look of games.

RED DAWN

AMD has some of the best-value graphics cards around, though it has recently dropped the 2xx series of cards, so some of the biggest bargains are no longer available. Even so, its 3xx series is rather good for the mid-range.

As with Nvidia, AMD has its own range of proprietary technologies that appear in a wide selection of games. The Mantle rendering engine is used to provide a performance boost over DirectX, while the TressFX hair simulation in *Tomb Raider* was optimised for AMD hardware. Again, proprietary technologies aren't that well supported, as games manufacturers don't want to alienate people with different graphics cards.

AMD has its own supersampling technology, called Virtual Super Resolution (VSR). This renders games at a higher resolution than your monitor supports, downscaling them to fit, for highly accurate anti-aliasing.

POWER UP

You need to make sure that you have a power supply that can handle your graphics card. The best way is to use the power requirements calculator at outervision.com/power-supply-calculator. This site will tell you the power rating (in watts) of the PSU you'll need for your particular computer.

PCI-Express slots don't provide enough power for graphics cards, so you have to provide additional power from your PSU. Most of the cards we've tested require one

Call the AA: anti-aliasing explained

Aliasing is the unavoidable effect that comes from using square pixels to draw diagonal lines. As screen resolutions increase, the effect becomes less prominent, but on today's 1,920x1,080 and 2,560x1,440 monitors aliasing (jagged edges) is still a major issue. A range of different anti-aliasing techniques reduce the effect, but these vary by game and by graphics card manufacturer. We use three different methods when testing graphics cards: Fast Approximate AA (FXAA), Multi Sampling AA (MSAA) and Super Sampling AA (SSAA).

FXAA is the least intensive form of anti-aliasing, as it doesn't actually analyse the 3D models onscreen; instead, it applies a smoothing effect to the entire scene as a post-processing filter. However, this means it blurs objects and textures that should be left alone, reducing the sharpness of the image. If your graphics card is powerful enough, it's worth opting for one of the other anti-aliasing modes.

MSAA requires more GPU resources, as it targets just the jagged lines for smoothing by detecting the edges of polygons. It's the method you should use if your graphics card can't cope with more demanding forms of anti-aliasing.

Finally, SSAA uses a brute force approach. At a basic level, the process involves rendering the scene at a higher resolution than your monitor natively supports, then downscaling it to display correctly on your screen. Enabling 4x SSAA on a game running at 1,920x1,080 essentially forces the graphics card to render at 3,840x2,160, effectively quadrupling the workload. It's the most intense anti-aliasing method out there, but it preserves visual clarity and is worth turning on if your graphics card can handle it.

six-pin PCI-E power connector; high-end cards need one eight-pin and one six-pin, or even two eight-pin connectors. You can use our table over the page to make sure that your PSU has the right connectors. If you need a new PSU, see pages 114 to 117.

Graphics cards vary greatly in length and height, depending on how big the actual GPU is, the size of the cooling system and the number of ports on the back of the card. Our PC case reviews starting on page 97 state how much room is available inside for graphics cards. You may need to remove one of the case's hard disk drive cages in order to fit very long cards. Not every card will fit in every case, particularly if you have a microATX or Mini-ITX chassis, so it's important to check before buying. Our specifications table shows the length of each graphics card we've tested.

It can be harder to find out a graphics card's width, which can be an issue in Mini-ITX and home theatre cases. You'll also need to take the placement of the power connectors into account, as shallow home-theatre cases might physically be able to fit the card, but power connectors on the side of the card could stop you from putting the case's top panel back on.

Most mid-range graphics cards take up two expansion slots, in order to accommodate a heatsink and cooling fan. These cards are known as dual-slot, and will obscure the slot directly beneath the one into which you plug the card (if there is one).

Finally, half-height or low-profile graphics cards are designed for ultra-compact home theatre PC or desktop form factor cases. These are typically less powerful than their full-height counterparts and can be noisier due to having smaller fans, so unless you have very limited space a full-height card will likely be a better option.

PORTS REPORT

Almost all modern graphics cards have at least one DVI port, for connecting to a monitor. If you have an older monitor with a VGA input, you'll need to use a DVI-to-VGA adaptor; our table on the following page tells you if one is included in the box. HDMI outputs are now fairly common on graphics cards; you'll want at least one of these if you plan on connecting your PC to a TV.

Be aware that many HDMI connections limit you to a 30Hz refresh rate at 2,560x1,440 or higher resolutions, which will make the Windows Desktop feel jerky. Also, on some cards with two DVI ports, one port may be a single-link model, which will only support displays up to 1,920x1,200 pixels; dual-link DVI supports up to 2,560x1,440 at 60Hz.

If you want to connect to a 3,840x2,160 (4K) monitor or one with a very high refresh rate, you're best off using a DisplayPort output, as this interface standard supports very high resolutions and refresh rates. Almost all the cards we've tested have at least one DisplayPort output; see our table for further details. You may also find Mini DisplayPort or Mini HDMI connections, but these aren't as convenient as their full-size counterparts as you'll need adaptors to connect them to most monitors.

Reality bytes: VR specs

Virtual reality looks set to become a big deal in 2016, with the likes of the Oculus Rift making a splash. The idea is simple: you strap on a set of goggles, giving you one screen per eye, for true 3D. Even better, as you move your head, the world updates, letting you look around as naturally as you do in real life. In this way, games will become fully immersive.

While the idea is simple, powering this kind of technology is a little harder: you need a graphics card that can produce double the number of frames, so each eye gets its own view. You also need a PC that can handle real-time head movements and tracking.

Nvidia has released its minimum VR specs for a new PC. These are an Intel Core i5-4590 processor, 8GB of RAM, two USB3 ports and a GeForce GTX 970 graphics card. For AMD graphics cards you need a Radeon R9 290 or higher, with the R380 from the newer generation proving more than capable.



AMD

RECOMMENDED	BEST BUY	
AMD	AMD	AMD
Radeon R7 370	Radeon R9 380	Radeon R9 380X
★★★★☆	★★★★★	★★★★☆

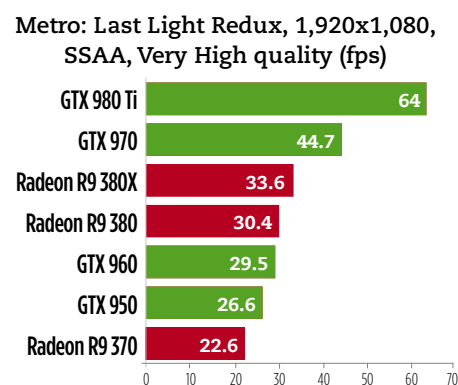
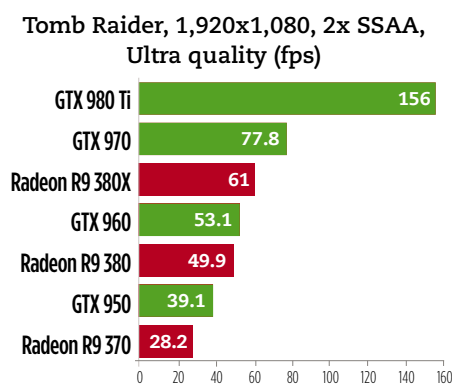
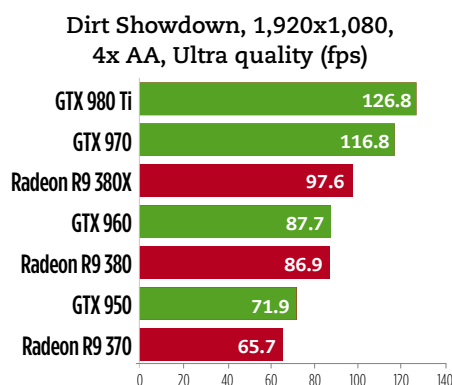
HARDWARE

Slots taken up	2	2	2
GPU cores	1,024	1,792	2,048
GPU clock speed	1,000MHz	990MHz	1,030MHz
GPU clock boost speed	1,050MHz	Not disclosed	Not disclosed
Memory	2GB GDDR5	4GB GDDR5	4GB GDDR5
Memory interface	256-bit	256-bit	256-bit
Max memory bandwidth	179GB/s	176GB/s	185.6GB/s
Memory speed	5,700MHz	5.7GHz	5.8GHz
Graphics card length	258mm	234mm	234mm
Outputs	2x DVI, 1x HDMI, 1x DisplayPort	2x DVI, 1x HDMI, 1x DisplayPort	2x DVI, 1x HDMI, 1x DisplayPort
Power leads required	1x 6-pin PCI Express	2x 6-pin PCI Express	2x 6-pin PCI Express
Accessories	DVI to VGA adaptor	1x 6-pin to 4-pin power cable, 1x 8-pin to 6-pin power cable	2x Molex to 6-pin PCI Express power adaptors

BUYING INFORMATION

Recommended model	MSI Radeon R7 370 Gaming 2GB	Gigabyte Radeon R9 380 Windforce	Sapphire R9 380X Nitro
Price including VAT	£131	£177	£196
Warranty	Three years RTB	Three years RTB	Two years RTB
Supplier	www.ebuyer.com	www.scan.co.uk	www.scan.co.uk
Details	www.msi.com	www.gigabyte.com	www.sapphiretech.com
Part code	R7 370 Gaming 2G	GV-R938WF2-4GD	11250-01-20G
Verdict	A decent entry-level gaming graphics card, although as our more demanding tests show, you may have to turn down graphical detail to keep frame rates up.	A spot-on mid-range card. This will cope with 1080p gaming with all modern games and will be the right choice for most people.	Quicker than its little brother, but only by a little. If you want a bit more oomph, this is a great card, but the R9 380 or GTX 960 are better value.

Benchmarks





NVIDIA

RECOMMENDED	BEST BUY	BEST BUY	
NVIDIA	NVIDIA	NVIDIA	NVIDIA
GeForce GTX 950	GeForce GTX 960	GeForce GTX 970	GeForce GTX 980 Ti
★★★★☆	★★★★★	★★★★★	★★★★☆

HARDWARE

Slots taken up	2	2	2	2
GPU cores	768	1,024	1,664	2,816
GPU clock speed	1,190MHz	1,279MHz	1,140MHz	1GHz
GPU clock boost speed	1,393MHz	1,342MHz	1,279MHz	1,075MHz
Memory	2GB GDDR5	4GB GDDR5	4GB GDDR5	6GB GDDR5
Memory interface	128-bit	128-bit	256-bit	384-bit
Max memory bandwidth	105.76GB/s	112.16 GB/s	224GB/s	336.5GB/s
Memory speed	6,610MHz effective	7,010MHz	7,000MHz	7GHz
Graphics card length	256.5mm	257mm	264mm	267mm
Outputs	1x DVI, 1x HDMI, 3x DisplayPort	1x DVI, 1x HDMI, 3x DisplayPort	2x DVI, 1x HDMI, 1x DisplayPort	1x DVI, 1x HDMI, 3x DisplayPort
Power leads required	1x 8-pin PCI Express	1x 8-pin PCI Express	1x 8-pin PCI Express, 1x 6-pin PCI Express	1x 8-pin PCI Express, 1x 6-pin PCI Express
Accessories	2x Molex to 8-pin PCI-Express, VGA to DVI adaptors	DVI to VGA adaptor, Molex to 8-pin PCI-Express adaptor	DVI to VGA adaptor	DVI to VGA adaptor, Molex to 8-pin PCI-Express adaptor

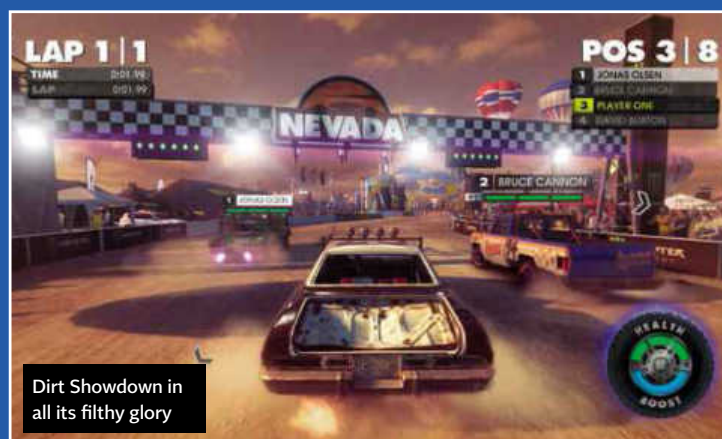
BUYING INFORMATION

Recommended model	EVGA GTX 950 SC	Gigabyte GTX 960 OC	MSI GTX 970 Gaming Twin Frozr 5	MSI GTX 980Ti Gaming 6G
Price including VAT	£128	£167	£276	£545
Warranty	Three years RTB	Three years RTB	Three years RTB	Three years RTB
Supplier	www.scan.co.uk	www.ebuyer.com	www.scan.co.uk	www.scan.co.uk
Details	www.evga.com	www.gigabyte.com	www.msi.com	www.msi.com
Part code	02G-P4-2957	GV-N960WF2OC-4GD	GTX 970 Gaming Twin Frozr 5	GTX 980Ti Gaming 6G
Verdict	Budget graphics cards don't come much better than this. You might have to turn down detail settings in some high-end games, but you get great performance for the price.	Ideal for mid-range gaming, with decent frame rates at 1080p in all our test games. It's a great price, too, and competes with the Radeon R9 380.	For most people, this card is the high-end model to buy. It will easily cope with high-resolution, high-detail gaming, making it a great choice for enthusiasts.	This card will cope with everything, even 4K gaming, but you're going to have to pay a lot for it. Unless you want and need the best, a cheaper card will suit most people.

How we test

We test all our graphics cards on an Intel DZ87KLT-75K motherboard with an Intel Core i7-4770K processor and 16GB of RAM. This system is powerful enough to ensure the CPU or memory isn't holding back the graphics card and artificially slowing down frame rates. We then use a range of different games, which vary in graphical intensity, to measure performance.

Dirt Showdown is our least challenging title, so should play well on mid-range GPUs without dropping below 60fps; racing games particularly benefit from high frame rates. The game scales well to 2,560x1440 and 4K resolutions when running on more powerful cards. 2013's Tomb Raider reboot uses very demanding SSAA, which will tax mid-range cards, while Metro: Last Light Redux makes heavy use of Tessellation to challenge all but the most powerful cards. We've printed the results of the graphics cards at 1,920x1,080, so you can see how they compare to each other.





STORAGE WARS

Hard disks and SSDs

Whether you want a lightning-fast SSD to make your PC boot faster or a regular hard disk to give you plenty of space for all your files, we've got the storage solution for you

FEW THINGS ARE as vital to a PC as its internal disk drive. Not having enough storage is hugely frustrating, as you have to uninstall programs to make room for the latest game, or copy files to external storage to download a rented film. Slow hard disks can also make your computer feel sluggish.

Both these problems can be solved with a drive upgrade. Mechanical hard disks are astounding value, providing thousands of gigabytes of storage for less than 3p a gigabyte. Meanwhile, solid-state drives (SSDs) are incredibly fast and can help your PC boot in seconds, as well as adding a welcome dose of operating system responsiveness. Hybrid drives try to bring you the best of both

worlds, combining the speed of an SSD with the capacity of a traditional mechanical disk.

Desktop PC builders don't have to choose between a hard disk and SSD, as you can have a fast SSD as your system disk, and store your files and documents on the slower hard disk. This month we'll help you find your perfect drive, with our guide to the best storage out there. Over the page, our full performance graphs and specs tables will help you pick the capacity and the drive you need from our recommended choices.

HARD LABOUR

Hard disk drives have been around for an eternity in technology terms. They provide by

far the highest storage capacity and are much cheaper than SSDs per gigabyte, so if you have lots of media and documents to store, they're your best option. If you're planning to use a hard disk drive for your operating system and applications, don't expect the same fast loading times and snappy system responsiveness as you'll get with an SSD, however, as even the slowest SSD is over three times as fast as the quickest hard disk.

Hard disk drives are often referred to as 'mechanical drives' due to the way they operate. A hard disk consists of a mechanical arm and, depending on its storage capacity, one or more platters. The arm holds the read/write heads that move across the platter



at extremely high speeds, as the platters themselves rotate at high speed, anywhere up to 10,000rpm. Data is stored on the surface of each platter, and the arm moves the heads over the surface of the disk to pick up data.

It's because of the mechanical nature of hard disk drives that they can't compete with the speed of flash storage found in SSDs, which doesn't rely on delicate moving parts. It's also why hard disks are more susceptible to impact damage, making dropping a laptop with a hard disk likely to result in data loss.

SO SOLID CREW

Installing an SSD can be one of the most effective upgrades you can make to your desktop or laptop. SSDs are an excellent choice for a primary system disk. Thanks to

their superior read and write speeds, they can instantly speed up your operating system, making it feel fresh and responsive. Bootup and shutdown times will be significantly less than when using a mechanical disk, and your applications will typically open much faster.

SSDs are able to achieve such blistering file-transfer speeds because of the lack of any moving parts. Rather than the disk platters found in HDDs, SSDs use NAND flash memory. NAND comes in a number of varieties based on how much data each of its cells can contain. There are the now less common single-level cell (SLC) type that can only store one bit, multi-level cells (MLC) that can store two bits and triple-level cell (TLC), which can store three.

Being able to store more than one bit of data per cell allows manufacturers to pack more storage capacity into a smaller physical

M.2 drives available at the moment, but we list our favourite models over the page.

HYBRID VEHICLE

Hard disk drives may still provide the best bang for your buck when it comes to storage capacity, but the read and write speeds of SSDs simply can't be beaten. The solution, therefore, would be to combine the two. That's what many manufacturers have done with solid-state hybrid drives (SSHDs).

Although many desktop PC users will opt for an SSD as a system disk to house their operating system and software, with a separate secondary hard disk for their media, this simply isn't possible in most laptops, where there's a solitary drive bay. This is where an SSHD could be a good compromise.

SSHDs combine both technologies into a single physical drive. Most have a large-

Our tests have shown that hybrid SSDs make some difference to file transfers, and can dramatically reduce operating system boot times

space, allowing the SSDs to reach ever-greater capacities while still fitting into existing drive bays. However, a balance needs to be struck, as using more bits per cell can result in compromised speed and reliability. There have also been some technological innovations allowing SSDs to increase in capacity further, such as Samsung's 3D V-NAND system, which stacks cells both vertically and horizontally. However, SSDs are still considerably behind HDDs in terms of storage capacity, and the cost per gigabyte is also a lot higher.

A separate controller acts as an interface between the NAND modules and the operating system, and this can have a direct impact on performance. For example, Marvell is a popular controller manufacturer, and its designs can be found in many SSDs from different manufacturers.

While a lot of SSDs connect to a SATA port (SATA3 is best for speed), some newer drives can plug into an M.2 port on your motherboard. This will give you even more speed, in a form factor that sits snugly against your motherboard. There are few

capacity hard disk paired with a smaller SSD NAND cache, typically around 8GB in size. Caching algorithms then decide what data should reside on the SSD and what will go on the hard disk. Typically, data you use most frequently will remain on the SSD cache for quick access, so these could be operating system files or software application data. This means performance should gradually improve over time as the caching algorithm learns your usage patterns. Our tests have shown that hybrid SSDs make some difference to file transfers, and can dramatically reduce operating system boot times.

Other hybrid drive implementations include Western Digital's Black2 Dual Drive. Instead of using an SSD as a cache, a separate HDD and SSD are packaged together in a single 2½in drive. This means you can use the smaller, faster SSD as your system disk, while still having plenty of mechanical hard disk space for your files. This is an excellent solution if you only have a single drive bay.

SIZE MATTERS

Storage drives typically come in two form factors: 2½in and 3½in. All SSDs are 2½in, but mechanical HDDs can come in either size. Most PC cases will be able to accommodate both sizes, but laptops only use 2½in drives.

Where it gets a little confusing is that there are different heights for 2½in drives. Most are 7mm high, but some are available in a thinner 5mm format often used in Ultrabooks or other slim laptops, or a thicker 9.5mm format often seen in large desktop-replacement laptops. We note how thick each drive is in our reviews, but if you're building a desktop PC the thickness doesn't matter.

How we test

To test the read and write speeds of each disk drive, we use a script that copies files to and from the drive and measures the time taken. We copy the files to the disk from memory rather than from another disk drive, because RAM is faster than any hard disk or SSD so won't act as the limiting factor in the tests.

In our large-file tests, we copy a 100MB file to and from each disk 100 times to see how fast a drive is when dealing with big files such as video clips. We repeat this test using a selection of smaller files totalling 100MB, to see how well a drive copes with the many smaller files needed when loading an operating system or application.

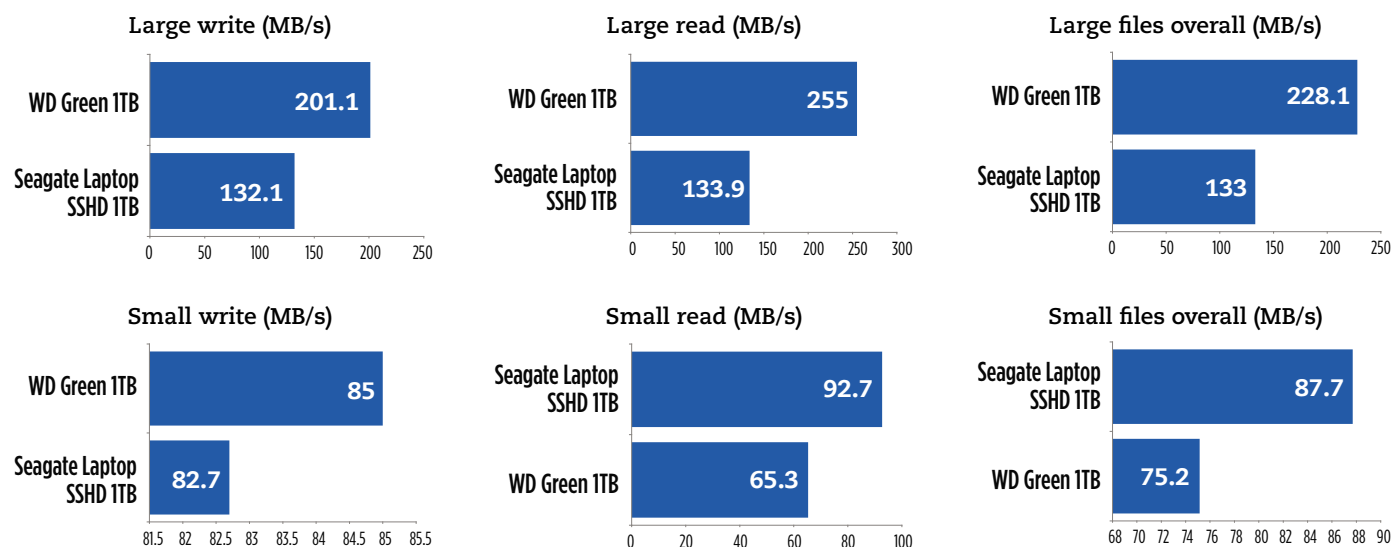


HARD DISKS

	RECOMMENDED	BEST BUY
	SEAGATE	WESTERN DIGITAL
	Laptop SSHD	Green
	★★★★☆	★★★★★
HARDWARE		
Form factor	2½in	3½in
Capacity	500GB/1TB	500GB/1TB/2TB/3TB/4TB
Cost per gigabyte	£0.09 (500GB), £0.07 (1TB)	£0.08 (500GB), £0.04 (1TB), £0.03 (2TB), £0.03 (3TB), £0.03 (4TB)
Interface	SATA3	SATA3
Spindle speed	5400rpm	IntelliPower
Cache	8GB SSD + 64MB	64MB
Quoted seek time	8ms	Not stated
BUYING INFORMATION		
Warranty	Three years RTB	Two years RTB
Price including VAT	£46 (500GB), £67 (1TB)	£40 (500GB), £43 (1TB), £64 (2TB), £82 (3TB), £118 (4TB)
Supplier	www.scan.co.uk	www.scan.co.uk
Details	www.seagate.com	www.wdc.com
Part code	ST500LM000, ST1000LM014	WD5000AZRX, WD10EZRX, WD20EZRX, WD30EZRX, WD40EZRX
VERDICT		
	Ignore the word 'laptop' in this product name: this hybrid drive is great value and its SSD cache can help improve boot speeds, from 50s down to 28s in our tests. The SSD cache is very small, though.	With excellent prices and great performance, the WD Green series is our hard disk of choice. The 2TB, 3TB and 4TB models are the best value per gigabyte, but buy according to budget.

Prices correct at time of going to press

Benchmarks



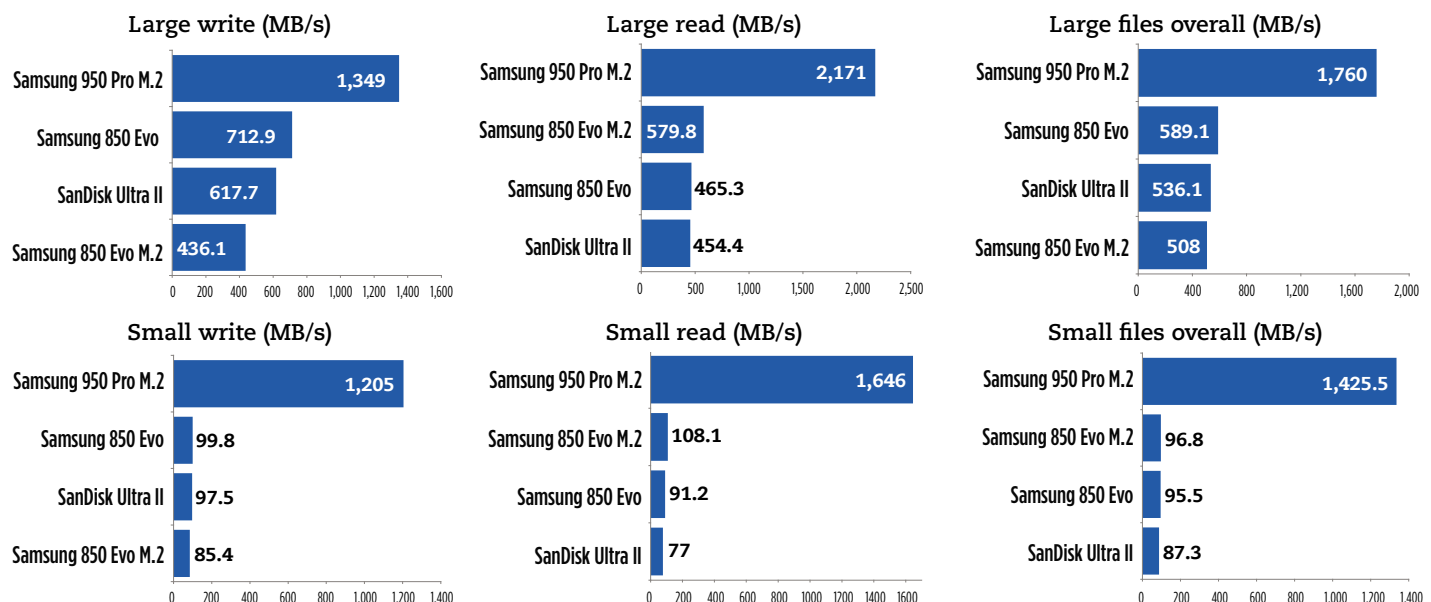


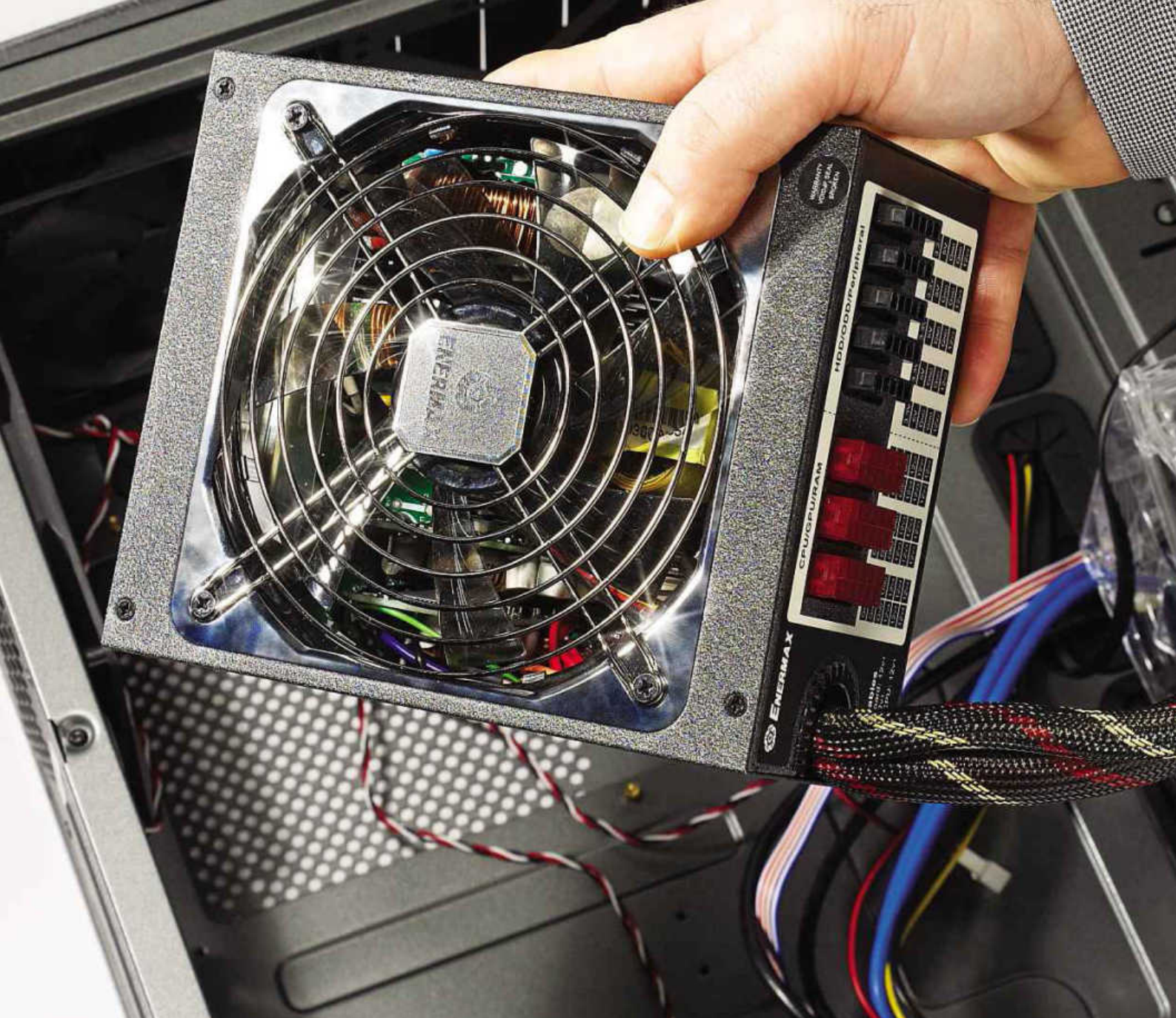
SSDs

	BEST BUY	RECOMMENDED	BEST BUY	RECOMMENDED
	SAMSUNG	SAMSUNG	SAMSUNG	SANDISK
	850 Evo	850 Evo M.2	950 Pro (NVMe) M.2	Ultra II
	★★★★★	★★★★☆	★★★★★	★★★★★
HARDWARE				
Capacity	120GB/250GB/500GB/1TB	120GB/250GB/500GB	256GB/512GB	240GB/480GB/960GB
Cost per gigabyte	£0.45 (120GB), £0.26 (250GB), £0.27 (500GB), £0.26 (1TB)	£0.46 (120GB), £0.32 (250GB), £0.30 (500GB)	£0.57 (256GB), £0.50 (512GB)	£0.38 (120GB), £0.29 (240GB), £0.23 (480GB), £0.21 (960GB)
Interface	SATA3	M.2	M.2 (NVMe)	SATA3
Claimed read	540MB/s	540MB/s	2,200MB/s	550MB/s
Claimed write	520MB/s	500MB/s	900MB/s	500MB/s
Controller	Samsung MGX Controller, Samsung MEX Controller (1TB)	Samsung MGX	Samsung UBX	Marvell 88SS9190/88SS9189
NAND flash type	Samsung 40nm 3D V-NAND	Samsung 3D V-NAND	Samsung V-NAND	19nm TLC
Mounting kit	No	No	No	No
BUYING INFORMATION				
Warranty	Five years RTB	5 years RTB	5 years RTB	Three years RTB
Price including VAT	£54 (120GB) £66 (250GB), £133 (500GB), £264 (1TB)	£55 (120GB), £80 (250GB), £152 (500GB)	£146 (256GB), £255 (512GB)	£46 (120GB), £70 (240GB), £109 (480GB), £200 (960GB)
Supplier	www.ebuyer.com	www.scan.co.uk	www.ebuyer.com	www.ebuyer.com
Details	www.samsung.com/uk	www.samsung.com/uk	www.samsung.com/uk	www.sandisk.co.uk
Part code	MZ-75E120BW, MZ-75E250BW, MZ-75E500BW, MZ-75E1T0BW	MZ-N5E120BW, MZ-N5E250BW, MZ-N5E500BW	MZ-V5P256BW, MZ-V5P512BW	SDSSDHII-120G-G25, SDSSDHII-240G-G25, SDSSDHII-480G-G25, SDSSDHII-960G-G25
VERDICT				
	Samsung's 850 series is now excellent value. It's still extremely quick, too, performing well across all of our tests. The 120GB drive isn't good value, but the other capacities are.	The M.2 version of Samsung's regular SSD. It's a little more expensive, but it's a little faster, too. If you have a motherboard with an M.2 slot, this is the best-value drive for it.	Incredible performance from this top-end M.2 SSD. It's comparatively expensive, but you'll have a really quick PC if you buy one. It's best suited for use with a new Intel Skylake system.	This range of SSDs is great value and still comparatively quick. It's the ideal choice if you value capacity over raw speed. The 120GB version's not great value, but the other capacities are.

Prices correct at time of going to press

Benchmarks





POWER RANGERS

PSUs

A decent power supply will not only give you the right connectors to power all your kit, it can also save you money on your bills

THE POWER SUPPLY unit (PSU) may not be the most exciting product inside a PC, but you shouldn't overlook it and just buy the cheapest model you can. An unbranded PSU may not deliver the wattage printed on its box and could therefore cause random instability and crashes. From experience, we've also found that cheap power supplies don't last as long as their branded equivalents.

For this month's issue of *Computer Shopper* we put 20 power supplies through their paces to see how well they performed under load. However, we've only included the top models that you should consider in this issue, giving recommendations that will suit all builds and all types of user. Before you jump into the

details, here's everything you need to know about choosing a power supply.

UNBRIDLED POWER

For a while the PC industry went mad and it wasn't unusual to see 1.2kW supplies for sale. The good news is that everything has become more power efficient. Typically speaking a 500-550W PSU will cope with a regular PC build with a single low-power graphics card. If you're going for something a bit more powerful, a 750-850W PSU will do the job. If you want a better idea of how much power you'll need to provide, the eXtreme Power Supply Calculator (outervision.com/power-supply-calculator) lets you select your

components using a drop-down menu, so you can get an accurate prediction.

AGAINST THE RAILINGS

A PSU outputs its power on different rails, which run at various voltages and have a rating in amps to show the total power they provide. Different parts of your PC draw on different rails for their power; power-hungry components such as the processor and graphics card, for example, draw a significant amount of power from one of the 12V rails. The rail's total rating figure is the amount of current that can be drawn by that single rail: multiply that by the voltage to find the total power that the rail can provide.

Branded power supplies will be able to provide close to their rated maximum wattage across their 12V rails.

EFFICIENCY DRIVE

Nowadays, efficiency is just about the most important part of any supply. This describes

Power supply ratings

Fraction of load	20%	50%	100%
80 Plus Bronze	81%	85%	81%
80 Plus Silver	85%	89%	85%
80 Plus Gold	88%	92%	88%
80 Plus Platinum	90%	94%	91%
80 Plus Titanium	94%	96%	91%

how much power is wasted when converted from input to output. Any 'lost' power is converted into heat. For example, a 500W power supply that's 85% efficient would need to draw 294W from the wall to power a 250W PC. In contrast, a 94% efficient PSU would draw 266W – 28W less to power the same PC. At an average cost of 13.52p per kilowatt hour (kWh) at standard rate, the first power supply would cost 3.97p per hour to run; the more efficient power supply would cost 3.6p per hour to run. Assuming eight hours of use per day, the first power supply would cost £116.07 a year; the second would cost £105.01 a year. That's a saving of £11 a year. That's not even to mention that the more efficient supply generates less heat, keeping your PC cooler.

To help you choose, power supplies are rated by the 80 Plus certification, with Bronze, Silver, Gold, Platinum and Titanium awards for minimum efficiencies (see the table, left). The 80 Plus standards set efficiency targets at 20, 50 and 100 per cent load. Our tests tell you



how efficient each supply is, but be careful in choosing by efficiency alone. In our example, you might buy a more expensive PSU to save on running costs, but it may take years of lower electricity bills to recoup the higher initial cost.

PLUG IN

Make sure your PSU has enough plugs for all your PC's components. If you want to run two powerful graphics cards, you'll need four 6+2-pin PCI Express connectors, for example. Plenty of SATA connectors are useful for hard disks and SSDs, but look out for older Molex connectors for old devices and case fans.

You may also need a Floppy connector if you have a front-panel device that is powered this way. Buy a modular PSU if you can (most are), as you only need to plug in the cables that you're using, leaving your PC less cluttered inside.

How we test

You need specialist kit to test power supplies properly. We use Stratton load generators, which are able to simulate a load of up to 1,600W on a PSU. The supplies are tested at 200W, 300W, 400W, 500W and, for the 750W and higher supplies, 600W, 700W and 800W. This lets us see if each supply can handle its full load. We also test for power efficiency: the percentage of power drawn from

the mains that is delivered to the PC's components, with the remainder being lost as heat. We test at the same loads and compile an average efficiency figure. Our results are shown over the page.

Finally, all our supplies are tested for noise in a sound-proof chamber. We measure noise at 10cm, with each PSU running at a load of 100W, 300W and 500W.



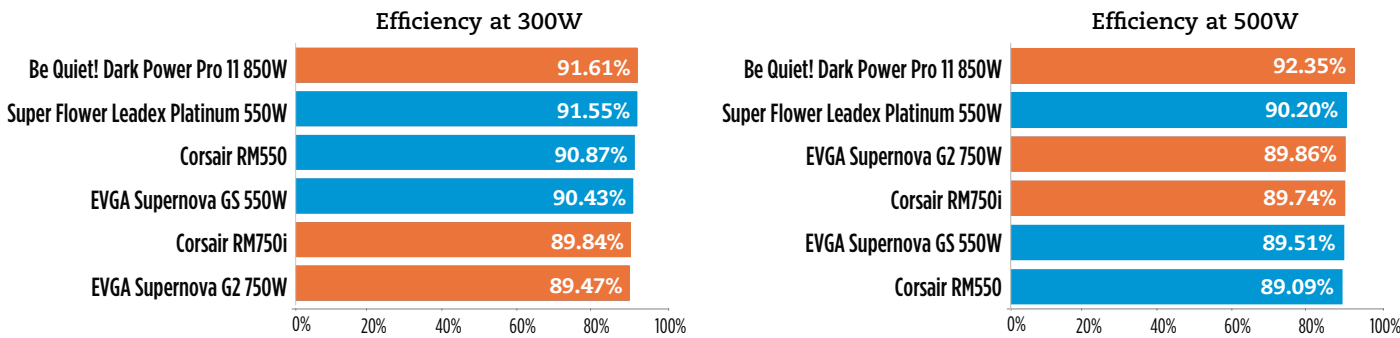
We use professional Stratton load generators to simulate a load of up to 800W on each PSU



550W PSUs

		RECOMMENDED	BEST BUY	
CORSAIR		EVGA	SUPER FLOWER	
RM550		Supernova GS 550W	Leadex Platinum 550W	
★★★★☆		★★★★☆	★★★★★	
FEATURES				
Fan	135mm	120mm	135mm	
Dimensions (WxDxH)	150x160x86mm	150x150x86mm	150x165x86mm	
CLAIMED OUTPUT				
3.3V rail	25A	20A	20A	
5V rail	25A	20A	20A	
12V rails	1 (45.8A)	1 (45A)	1 (45.8A)	
12V rails max output	45.8A	45A	45.8A	
Maximum total output	550W	550W	550W	
80 Plus certification	80 Plus Gold	80 Plus Gold	80 Plus Platinum	
CONNECTIONS				
Modular	Yes	Yes	Yes	
Molex	4	4	4	
SATA	6	6	7	
Floppy	1	1	1	
Motherboard connector	20/24-pin	20/24-pin	20/24-pin	
Four-pin 12V processor	Yes	Yes	Yes	
Eight-pin 12V processor	Yes	Yes	Yes	
SOUND				
100W load	18dB(A)	23.3dB(A)	18.6dB(A)	
200W load	18dB(A)	24.4dB(A)	19.8dB(A)	
500W load	28.8dB(A)	28.8dB(A)	26.1dB(A)	
BUYING INFORMATION				
Price including VAT	£91	£71	£88	
Supplier	www.ebuyer.com	www.ballicom.co.uk	www.overclockers.co.uk	
Details	www.corsair.com	www.evga.com	www.super-flower.com.tw	
Part code	CP-9020053-UK	220-GS-0550-V3	SF-550F14MP	
VERDICT				
Lengthy, flat cables and a large, quiet fan are just the start for this top PSU. With excellent efficiency from 100W upwards, only its price holds it back.		If you're building a budget computer, this is the PSU for you. Voltage drops a little at high loads, but remains within the ATX specification.		Inaudible during normal operation and with 80 Plus Platinum certification, this is the top PSU for anyone that needs up to 550W of power.

Benchmarks





750-850W PSUs

BE QUIET!

Dark Power Pro 11 850W

★★★★☆

135mm

150x193x86mm

25A

25A

4 (2x 30A, 2x 35A)

70A

850W

80 Plus Platinum

Yes

8

8

1

20/24-pin

Yes

Yes

18.2dB(A)

18.9dB(A)

21.9dB(A)

£158

www.dabs.com

www.bequiet.com

BN253

It's expensive, but this PSU is incredibly well built and extremely efficient. Integrated fan controllers are a nice touch, but the price is hard to get over.

CORSAIR

RM750i

★★★★☆

135mm

150x180x86mm

25A

25A

1 (62.5A)

62.5A

750W

80 Plus Gold

Yes

7

8

2

20/24-pin

Yes

Yes

18dB(A)

19.6dB(A)

23.5dB(A)

£104

www.scan.co.uk

www.corsair.com

CP-9020082-UK

At 180mm long this is a big PSU, so make sure you have room for it. If you do, you get excellent efficiency and whisper-quiet operation, thanks to the large 135mm fan.

BEST BUY

EVGA

Supernova G2 750W

★★★★★

140mm

150x180x85mm

24A

24A

1 (62.4A)

62.4A

750W

80 Plus Gold

Yes

4

9

1

20/24-pin

Yes

Yes

20.1dB(A)

18.5dB(A)

32.8dB(A)

£93

www.scan.co.uk

www.evga.com

220-G2-0750-XR

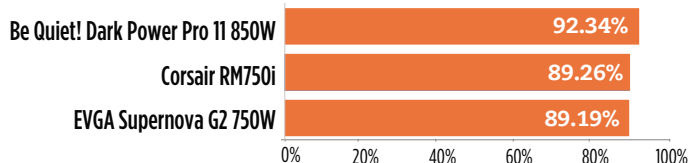
A fully modular design and excellent efficiency above 100W make this a great-value PSU. For most people building a high-power system, this is the best choice.

Prices correct at time of going to press

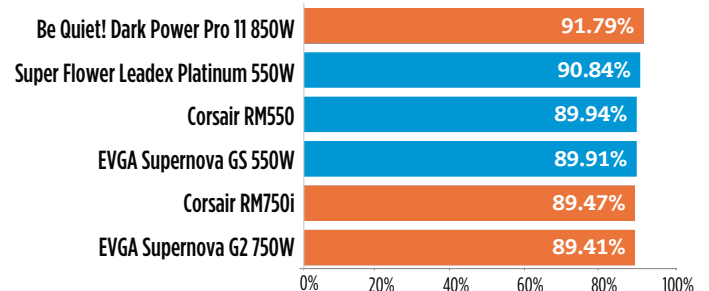
550W PSUs

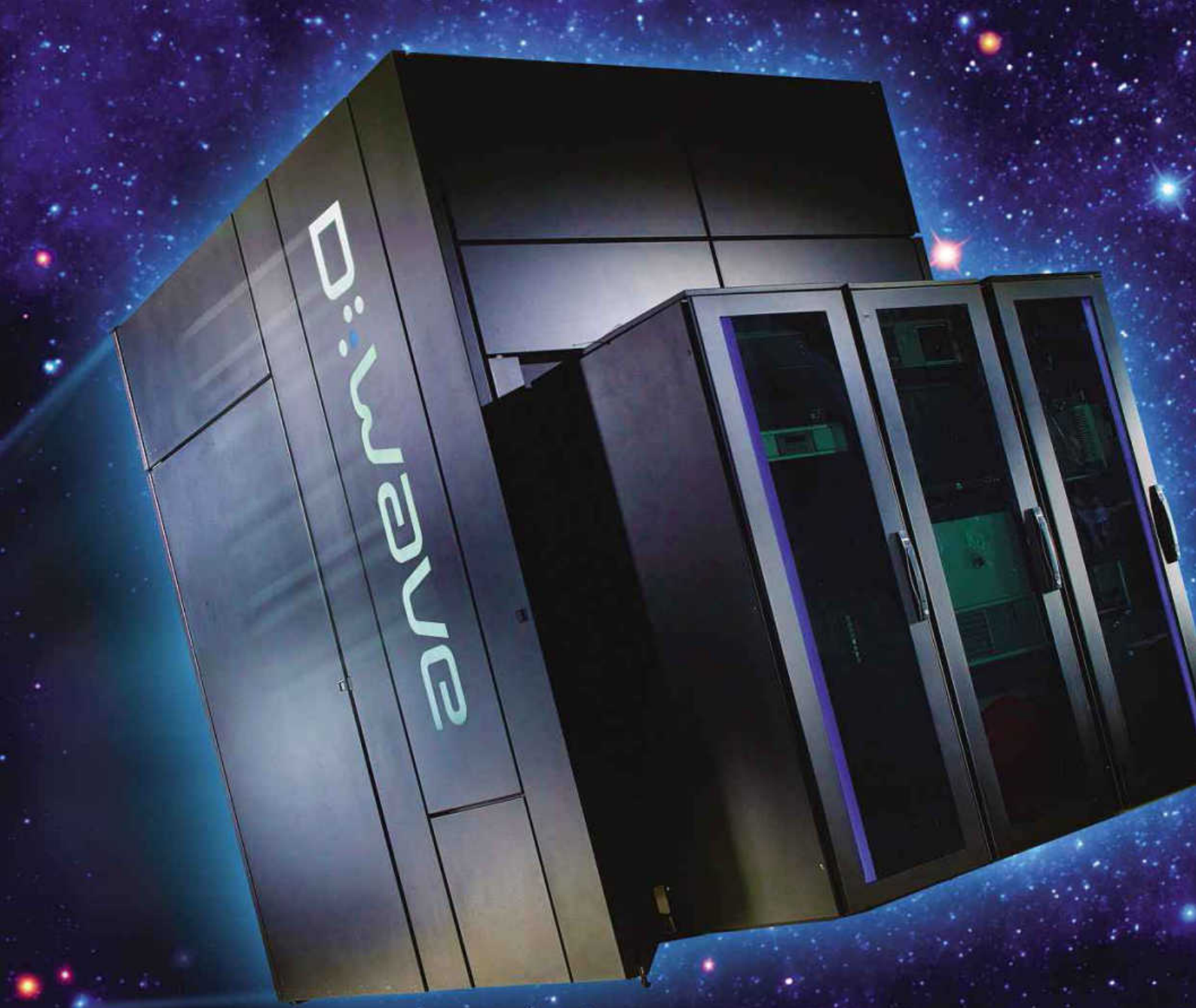
750-850W PSUs

Efficiency at 700W



Average efficiency





QUANTUM LEAP

GOOGLE AND **NASA'S** ONE SMALL STEP FOR
QUANTUM COMPUTING COULD PROVE TO BE A
GIANT LEAP FOR MANKIND. BY MIKE BEDFORD

In the last 45 years conventional computing has seen performance increases of around two million-fold, an astonishing rate that has changed the way we live. So when two organisations as respected as Google and NASA announce a 100 million-fold increase in computing performance, the potential outcome is nothing less than world-changing.

That incredible figure is the product of quantum computing, and of course it comes with one or two caveats. But with such big names behind it, we're confident that we're seeing a huge step forward in the viability of quantum computing to solve the world's toughest problems.

The announcement didn't come out of nowhere. Research on quantum computers has been running for decades, and Google and NASA's own efforts in this particular case date back three years. It was then that they shelled out a serious chunk of money on the one and only commercially available quantum computer, from controversial pioneers D-Wave.

The intervening months went by with little more than the odd hint at what these organisations were doing with their new toy in their Quantum Artificial Intelligence Lab (QuAIL). Until finally, in December 2015, the 100m-fold claim was made. We've now talked to researchers at QuAIL to bring you the full story and its potentially huge impact.

To make any sense of that, though, we'll need to turn the clock back a bit and lay some groundwork of our own.

BACK TO BASICS

The computer that prompted this investigation into quantum computing is a rather special type of quantum computer but, to set the ball rolling, we'll look at the universal quantum computer. This sort of computer has most in common with today's conventional computers, and has exercised the minds of many researchers over the past few decades.

Descriptions of quantum effects often start with a disclaimer along the lines of, 'this is really weird stuff and you're not going to understand it'. While there's an element of truth in that, being less flippant we could say that in the quantum realm – that is, when we're dealing with unimaginably tiny things like individual electrons or photons – common sense no longer applies, and things behave in strange ways.

Let's take an example. In digital electronic circuits, things are in one of two states that represent the zeros and ones of binary arithmetic. Normally these states are represented by the properties of a bunch of electrons, but we can envisage that it might be possible to use the properties of a single electron to represent a zero or a one. An electron has a property referred to as 'spin', which can be 'up' or 'down'. In reality, it's not spin as we understand the word, and the properties of up and down don't really have parallels in the non-quantum world, but the important point is that they could, potentially, represent zeros and ones. But here's where it gets strange.

The spin of an electron can be caused to flip between states by applying energy while it's in a magnetic field. A specific amount of energy is required to cause the spin to flip, and it's what happens when insufficient energy is used that's really interesting. Because spin can only ever be up or down, the spin can't partially flip but, instead, it enters a so-called state of superposition. This is like being both up and down simultaneously or, in binary terms, 0 and 1 at the same time.

NEITHER ONE NOR T'OTHER

Frustratingly, a state of superposition can't be observed. It's not that nobody has figured out how to do it; rather it's been proven that attempting to observe it will cause the state of superposition to be lost – decoherence, as it's called. So, reading the state of an electron with a zero/one superposition will only give a value of zero or one. In an equal superposition – one in which zero and one have equal probabilities – if you carried out the experiment lots of times, half the time you'd get a zero and half the time you'd get a one.

It would be tempting to believe, therefore, that the state of superposition had never really been achieved and that the spin simply flipped half the time. However, scientists have shown without doubt that superposition does exist, and they've even harnessed the effect to carry out quantum computations.

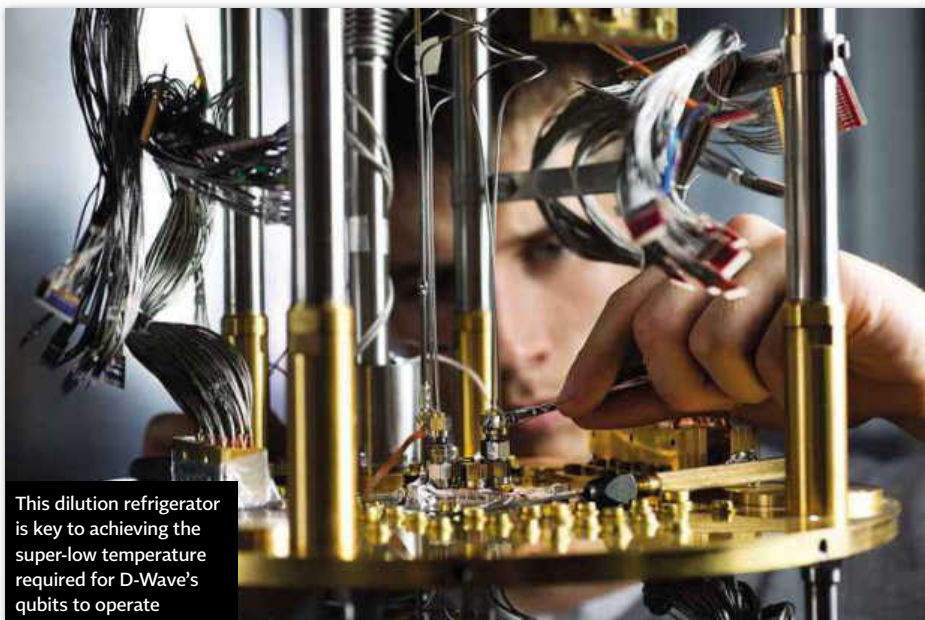
It might seem inconceivable that this effect can be harnessed for computing if reading the answer destroys it, revealing just a single result. However, although billions upon billions of calculations might need to be done in some of the most difficult tasks carried out by today's computers, often only a handful of answers are required. The strength of a

quantum computer, therefore, is its speed in carrying out all those intermediate calculations, and it's not hard to see how it could achieve that.

We've seen that a single bit – or a qubit, as a bit in a quantum computer is called – can hold the values of zero and one simultaneously. Just as a register of eight bits in a conventional computer can hold any value between 00000000 (0) and 11111111 (255), in a quantum computer, a register of eight qubits can hold all 256 values at the same time.

More importantly, any calculation performed on that register will result in 256 parallel computations also occurring. This parallelism increases exponentially so, by the time we get to the equivalent of today's 64-bit processors, a quantum computer could perform 18 quintillion – that's 18 billion billion – parallel calculations at a single stroke.

A quantum computer that worked in much the same way as the processor in



This dilution refrigerator is key to achieving the super-low temperature required for D-Wave's qubits to operate

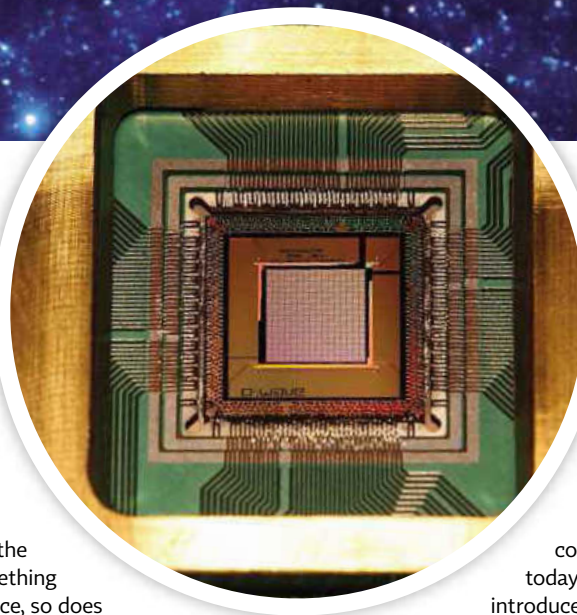
your PC by executing logic and arithmetic instructions sequentially, but using qubits instead of bits, would be a universal quantum computer. Like today's computers, it would be able to carry out pretty much any logical problem but, so long as the registers were as large as those in today's processors, it would do so immeasurably faster, at least for some applications.

This has been the goal of most quantum computing researchers since the 1990s, but progress has been slow. The difficulty lies in the fact that, just as any attempt at reading something in a state of superposition causes decoherence, so does any unintentional interaction with the environment.

To make things more difficult, a quantum computer depends on the qubits in a register being 'entangled'. This peculiar quantum effect means that none of the qubits can be thought of individually. If this effect were scaled up and we had two entangled coins that were flipped at the same time, either both would show heads or both would show tails, but never one of each.

However, because of that property, maintaining superposition becomes increasingly difficult as the number of qubits increases; if one of them decoheres, all will suffer that same fate. Scientists have tended to use esoteric means of preventing interaction with the environment, for example suspending single particles in free space using electric fields. In the early days, they managed to ramp up the number of qubits from two to around a dozen, but increases to the sort of figure needed to realise the true potential of quantum computing have proved elusive – or so it seemed.

It's important to recognise that a lot more than 32 or 64 qubits will be needed to produce a practical quantum processor, just as a conventional 64-bit processor contains hundreds of 64-bit wide registers, even if we exclude the cache. But while the headline figures may not have increased much, behind the scenes



◆ The processor in D-Wave's latest 2X quantum computer boasts 1,097 qubits

developments have brought the prospect of universal quantum computing a lot closer, as a raft of recent announcements have shown.

THE D-WAVE STORY

We'll come back to these developments later to concentrate on the key commercial player in quantum computing today, D-Wave Systems in Canada. D-Wave first introduced a 28-qubit computer in 2007 and the company has increased this, in leaps and bounds, to the 1,097-qubit D-Wave 2X that was introduced last year.

Given the huge discrepancy between the figures reported in scientific papers and those claimed by D-Wave, it's hardly surprising that the company has had its critics. Many quantum computing experts were vociferous in their dismissal of D-Wave computers, claiming they didn't really employ quantum effects, with the most outspoken accusing the company of deception.

While the world of academia had its doubters, NASA and Google took D-Wave's claim seriously. Or at least seriously enough to shell out \$10 million on a 512-qubit D-Wave Two, later upgraded to a 1,097-qubit D-Wave 2X system. Together with the Universities Space Research Association, they set up QuAIL at NASA's Ames Research Center in Moffett Field, California.

We didn't hear a lot about the initiative, however, until last December, when NASA invited the world's press to see its acquisition and Google promised a "watershed announcement".

Put simply, NASA and Google revealed that the D-Wave 2X had achieved a 100 million-fold speed improvement over a single Intel Xeon E5-1650 core running at 3.2GHz. This implied that the machine genuinely does employ quantum effects after all. While

SQUIDS IN: D-WAVE'S MAGIC

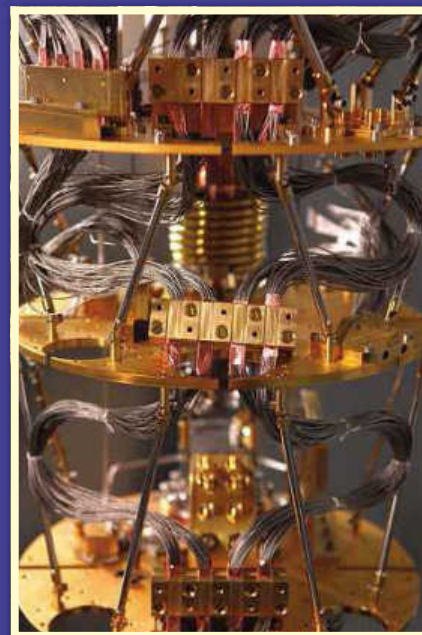
Quantum computing researchers have previously tended to implement qubits using single particles such as electrons, ions or photons, but D-Wave has managed to scale things up so quantum effects can be observed at a macro scale. This means the qubits can be interfaced with conventional electronic circuitry and implemented as silicon chips. D-Wave's qubits take the form of devices called SQUIDs – Superconducting QUantum Interference Devices.

They're rings of the element niobium, in which the direction of the flow of a current defines a 0 or a 1 but superposition can only be achieved if they're cooled to within a fraction of a degree of absolute zero. The necessary conditions have been described as 180 times colder than interstellar space.

As any interaction with the environment would cause the qubits to lose their state of superposition, D-Wave has had to go to great lengths to isolate the processor from the outside world. First, because the

quantum processor is adversely affected by stray magnetic fields, extreme care had to be taken to exclude them. This requires a magnetic shielding subsystem that reduces any such fields to less than 1 nanotesla – around 50,000 times less than the Earth's magnetic field. This is achieved using multiple shields, some of them made of Mu-Metal, a soft magnetic nickel-iron alloy that nullifies the Earth's magnetic field.

Excluding electromagnetic noise is also essential, so the system sits in a shielded enclosure that cuts out all radio frequencies. The only path for signals between the inside and outside of the shielded enclosure is a digital optical channel carrying programming information in, and results of computations out, and these are heavily filtered. Add to this the fact that the processor has to be housed in a high-vacuum environment in which the pressure is 10 billion times lower than atmospheric pressure, and you'll get some idea of how sensitive this circuitry is.



Here the D-Wave 2X's cryogenic refrigerator is being wired, key to cooling the processor to a temperature of 15 thousandths of a degree Kelvin

their comparison only involved a single core, it seems to be an impressive result, as a few simple calculations reveal.

Today's fastest supercomputer, China's Tianhe-2, harnesses the power of over three million cores. However, it cost \$390 million to build and you'd need 32 of them to get enough cores to equal the performance of the D-Wave 2X. The total cost, therefore, would be in the region of \$12 billion, compared to merely \$10 million for the D-Wave system.

Some experts are still taking these results with a pinch of salt, but there's one vital point we need to make about D-Wave's approach to quantum computing: its machines are not universal quantum computers. Instead, they support something called a quantum annealing architecture, which is designed to solve a particular type of problem that proves taxing for conventional computers (for more on this, see the box on the right).

APPROACH SHOT

Given that the evidence points to the existence of a working quantum annealing computer while the universal equivalent is still on the drawing board, let's look at how the two approaches compare – to find out whether this different approach represents the future of quantum computing, or whether it's just a stop-gap measure until something better comes along.

We spoke to NASA's Davide Venturelli, currently in charge of surveying the investigations performed at QuAIL, about the sorts of problems the D-Wave system can be used to solve.

The application that achieved that 100 million-fold speed increase was a specially written benchmark – software designed specifically to test the hardware. But according to Venturelli,

YOU'D NEED 32 OF TODAY'S FASTEST SUPERCOMPUTERS TO EQUAL THE PERFORMANCE OF THE D-WAVE 2X

many important real-world applications have similar properties. "The features of this application appear in almost all large-scale useful 'hard' problems," he said.

Google has given some indication of what these applications might be by referring to machine learning. The company said: "Machine learning is all about building better models of the world to make more accurate predictions. If we want to cure diseases, we need better models of how they develop. If we want to create effective environmental policies, we need better models of what's happening to our climate. And if we want to build a more useful search engine, we need to better understand spoken questions and what's on the web so you get the best answer."

Better online searching will benefit us all, but quantum applications tend not to be everyday tasks. We asked Venturelli if he ever envisaged a day when we might have this sort of hardware on our desks. "I don't envisage such a day before 2050," he said, "but I think we will have access to quantum computing in the Cloud as a SaaS (software as a service) much before that."

Given that, for many years, all the talk about quantum computers revolved around universal quantum computers but D-Wave got to market first with a very different quantum architecture, we were keen to know whether the universal approach has been marginalised or whether there's a place for both. Alternatively, perhaps, when the universal quantum computing comes along, might it mark the end for quantum

QUANTUM ANNEALING

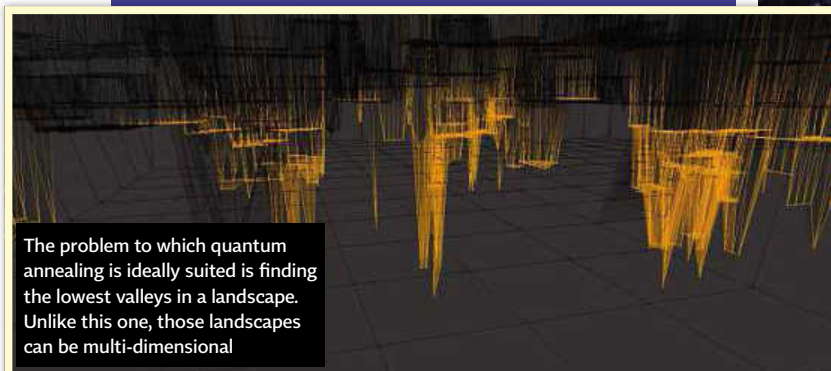
While there are lots of things the D-Wave 2X can't do – unlike a universal quantum computer, should one come to fruition, which could solve any problem that can be expressed in logical terms – its quantum annealing approach is well suited to optimisation, an area where ordinary computers struggle. Elsewhere we see some examples of how speeding up optimisation problems can offer many real-world benefits, but what does D-Wave mean when it says that its computers use a quantum annealing architecture? You'd probably need a PhD in quantum physics to understand fully, but hopefully our layman's explanation will give you an inkling.

It's well known that to get the best fuel economy from your car you need to drive at an optimum speed, which is around 50mph. If you didn't know this and had an equation relating fuel consumption to speed, it would be simple to find by working out the fuel consumption for a range of speeds and selecting the lowest. This is called optimisation, and it involves just a single variable – speed – so the relationship can be shown as an ordinary graph. The task of optimisation involves finding the lowest point on that graph.

Things get more complicated when we have more variables. If we have two variables, the relationship can be thought of as analogous to a landscape in which one variable is the latitude and the other the longitude. Now optimisation involves finding the lowest valley in the landscape. Trying out all the combinations of the two variables is one possibility, but it takes a lot longer than with one variable and the time increases exponentially as additional variables are added.

We'll continue to think, here, about two variables because it's easy to visualise a two-dimensional landscape, but the same principles apply with more variables and, hence, with a multi-dimensional landscape. With a classical computer, a better solution than trying out every combination is to start at a random spot on the surface, look around for a lower spot to walk down to, and repeat until you can't walk downhill any more. While this can work, it's all too easy to end up in a 'local minimum', being unaware that there's a lower point over another mountain or ridge.

Clever algorithms can go some way to overcoming this but they are hungry for computing power. With a quantum annealing computer, you can 'tunnel' through a ridge to see if there's a lower valley hidden beyond it. The process has been likened to flooding the landscape with water and looking for the places where the water accumulates, and it's possible because of the strange property of qubits to hold multiple values at the same time. So, while a conventional computer can look at one place at once on a landscape, a quantum computer can see all places at the same time.



The problem to which quantum annealing is ideally suited is finding the lowest valleys in a landscape. Unlike this one, those landscapes can be multi-dimensional

annealing, just as the digital computer ended up marginalising and then replacing the analogue computer (see *Shopper 333*).

We put these points to Venturelli, who thinks that quantum annealing might represent a stepping stone. "The approach taken by D-Wave is one of the many possible routes to a universal quantum computer," he said. "The importance of universal quantum computation has not diminished, but the focus to near-term approaches is justified because, before D-Wave, we were not really sure we could have moderate scale devices that exploit quantum effects in a useful way for computation so soon. I have a feeling that quantum annealing will evolve to a universal quantum computing platform somehow, but it is hard to tell."

UNIVERSAL DEVELOPMENTS

While early experiments into quantum computing tended to be carried out in the world of academia, several well-known computer companies are now taking an interest, and a few have nailed their colours to the mast in predicting future timescales. Just a few

months ago Intel teamed up with the Delft University of Technology (TU Delft) and TNO, the Dutch Organization for Applied Research, in a \$50 million project that aims to accelerate advancements in quantum computing. Microsoft, meanwhile, is also active in the field and has indicated that a practical quantum computer might be only 10 years away. IBM has been making important strides in quantum error detection and correction, even though it means that several physical qubits have to be used to create one logical qubit. And then there's Google. Quite separately from its involvement with NASA in examining the potential of D-Wave's computers, Google has joined forces with researchers from the University of California, Santa Barbara, to develop its own quantum computing hardware.

While all of these various research initiatives represent the whole gamut of quantum computing technologies, some of them aim to deliver the holy grail of universal quantum computing. We talked to Professor Lieven Vandersypen at TU Delft, who referred to several recent developments that seem to make the universal

MOORE'S LAW FOR QUANTUM COMPUTERS

Moore's Law is well known to those who take an interest in technology. Intel pioneer Gordon Moore suggested in 1965 that the number of transistors in mainstream chips would double every year, later amending it to a doubling every two years. Although the end might be in sight, that prediction has proved true for 50 years. This raises the intriguing question of whether a similar trend might apply to quantum computers.

Apparently so, according to D-Wave founder Geordie Rose and, what's more, it's been dubbed Rose's Law. In Rose's vision of the future, which he suggested in 2002, the number of qubits in the firm's quantum computers would double every year, "more or less like clockwork". A graph recently published by D-Wave, reproduced here, suggests that Rose's Law is on track and hasn't even had to be shifted down a gear, as Moore's Law was 10 years on.

In one important sense, Rose's Law is different to Moore's Law. In fact, it's been referred to as Moore's Law compounded, or an exponential on top of an exponential. Moore's Law refers to a doubling in the transistor count in a particular time period, which is a description of exponential growth. Drawn as a graph against time, the number of transistors increases with the line heading upwards ever more steeply, unless it's drawn on a logarithmic axis, in which case it appears straight.

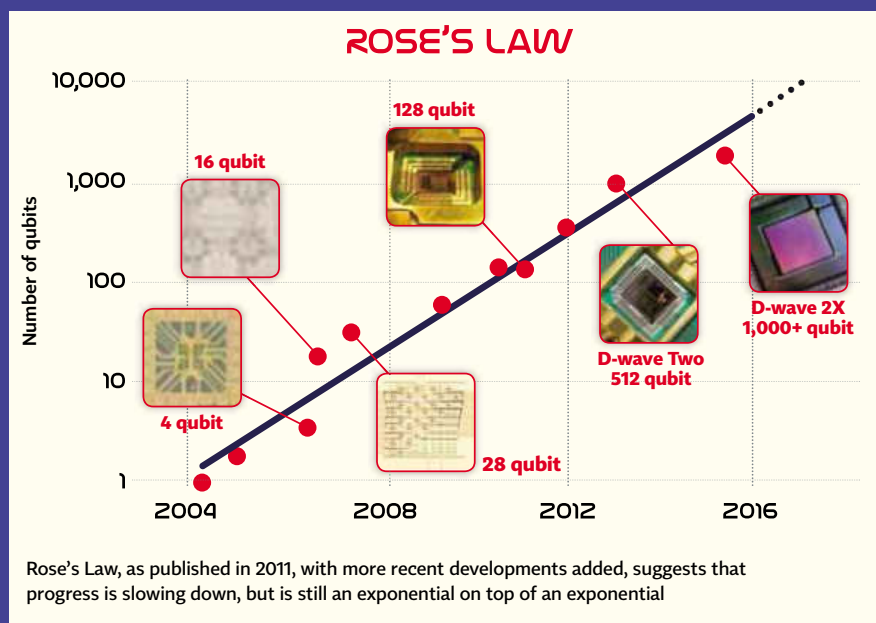
Since the power of a classical computer goes roughly hand-in-hand with the transistor count, performance also increases exponentially. Rose's Law also suggests that the qubit count will increase exponentially, but here's the difference. Unlike a conventional computer, you don't have to double the qubit count to double

the power: you only have to increase it by one. So the relationship between qubits and performance is also exponential, hence the reference to Moore's Law compounded.

This represents a phenomenal rate of growth and perhaps explains some of the astonishing predictions that appear on the original graph of Rose's Law, released by D-Wave's Steve Jurvetson in 2011, referring to times not far into the future, some of which have now passed. First was the claim that quantum computers would become faster than classical computers and, not long after, that a single quantum computer would be faster than all the computers in the world. Google's recent announcement suggests that the first of those milestones

has already been passed and that we're probably not too far from the second. However, this is for a single application on a specialised quantum computing architecture. For most applications, quantum computers have a long way to go to match conventional technology.

Even so, we can't help point out one prediction from that 2011 graph that sounds totally bizarre, namely "faster than the universe". This has been taken to mean that if the total amount of material and energy in the universe were to be harnessed into a conventional super-computer, it wouldn't match a single quantum computer. Perhaps you'll excuse us if we remain just a little bit sceptical.

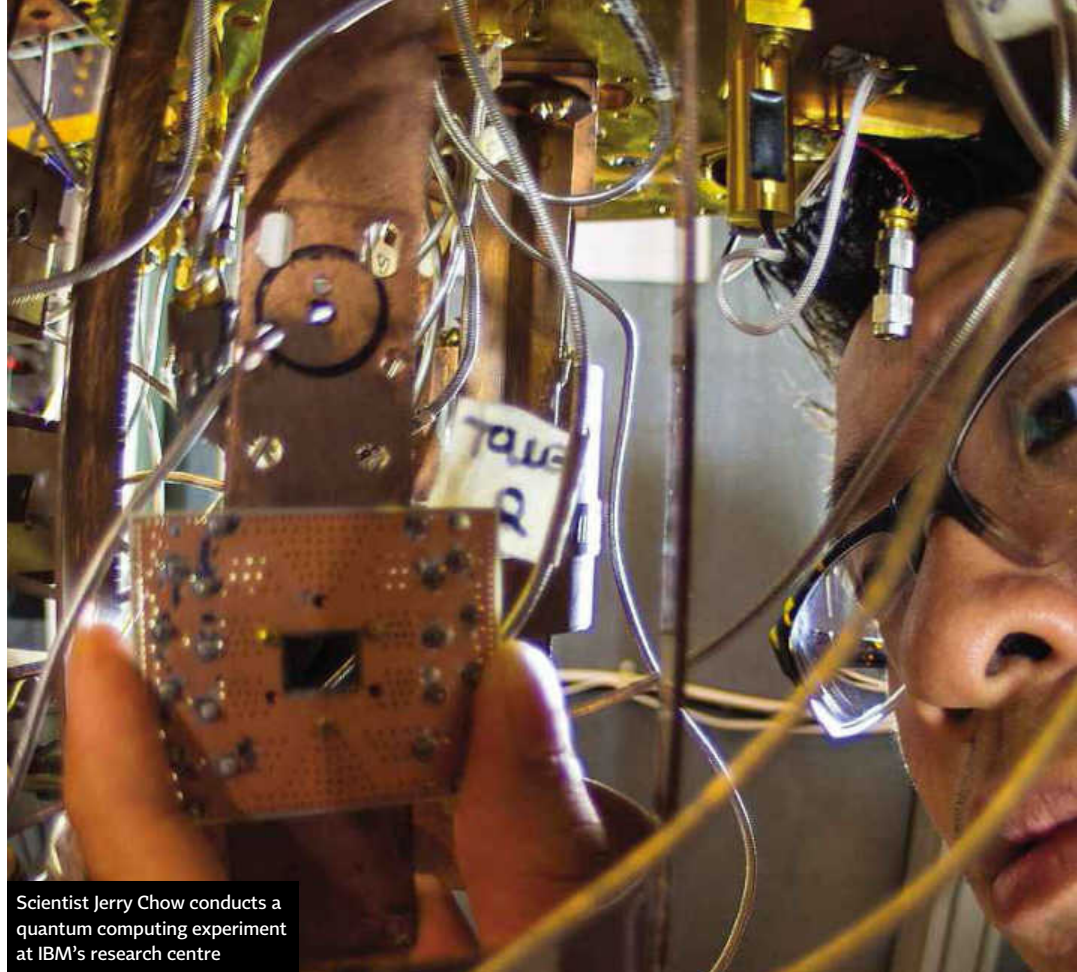


quantum computer more likely. "There were two advances of the last few years that have made me much more optimistic than a few years back," he told us.

"First, the error rate we can tolerate for quantum error correction has jumped significantly; and second, coherence times for solid-state qubits have gone up by orders of magnitude by new materials developments." However, he did have one important proviso. "If people say that a practical machine may be possible in a dozen years or so, they also count on progress in algorithms for 'few-qubit' applications; ie, on finding ways to make use of hundreds of qubits rather than many millions. I think there is good reason for optimism here."

According to Prof Vandersypen, there's still a lot to be done. "A number of scientific challenges remain to be addressed, every step we take has never been taken before and it takes time to figure out the right ways to do things. This includes making large numbers of qubits that are all identical, developing control electronics – possibly partly cryogenic – for addressing these large numbers of qubits, coming up with suitable interfaces and interconnects to pass on all the measurement and control signals, and designing a full quantum computer architecture. QuTech (a collaboration between TU Delft and TNO) is working on all these aspects, together with Intel and others.

So far, so good, but what could a universal quantum computer be used for? After all, the usual answer is factoring large numbers



Scientist Jerry Chow conducts a quantum computing experiment at IBM's research centre

and, in so doing, enabling all today's ciphers to be cracked in an instant. But potentially derailing the online security on which commerce is so reliant sounds more like a liability than a benefit. We asked whether this architecture truly will be universal and, if so, what the real killer apps will be.

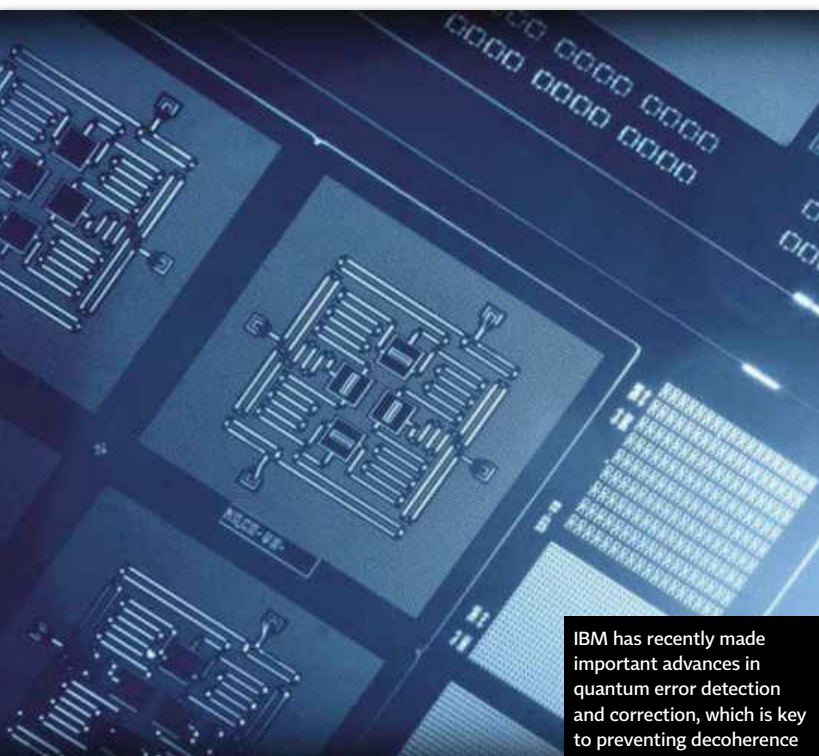
According to Prof Vandersypen, it will be genuinely universal. "By universal we mean that it can be programmed to solve any problem for which there exists an algorithm – quantum or classical," he explained. He then went on to refer to likely applications. "What motivates me most are the quantum algorithms achieving exponential speed-up for simulating molecules and materials, which may contribute to the development of new drugs, to designing materials for transporting or storing electricity without losses, and so forth".

He was even optimistic that quantum computing will eventually go mainstream. "Currently known applications are not for immediate consumer use, but who knows how the field will develop? I am hopeful that many more applications will be discovered, including mainstream applications."

THE ELUSIVE QUANTUM FUTURE

So it seems that an application-specific quantum computer is now with us – although some experts remain to be convinced – but the universal quantum computer still hasn't escaped from the research labs. After decades of promise, though, many researchers believe that it will break out in the next 20 years, and possibly a lot sooner than that. While you might never have one on your desk, huge benefits to humanity are expected.

Intel and Microsoft have ongoing quantum computing research initiatives, and we might reasonably expect that these major players in the world of classical computers might lead the way with the quantum alternative. Both companies declined our invitation to suggest what the future holds. Does this suggest that the mooted 10- to 12-year timescales are over-optimistic or that they're just playing it safe? We'd have to conclude that the future of quantum computers is as hard to pin down as an electron in superposition. **CS**



IBM has recently made important advances in quantum error detection and correction, which is key to preventing decoherence




MINECRAFT

Striking gold

How did a game with simplistic graphics, no recognisable characters and no clear aim become the software success story of the decade?

Barry Collins explores the Minecraft phenomenon to find out



To dismiss Minecraft as 'just a game' is like calling the Titanic 'just a boat'. It's the only true digital sandbox, an art form, an educational playground and increasingly a focal point for families in the same way a television set was 30 years ago. It's the basis of massive clan wars and a place for people to build peacefully together. It's made millionaires out of twenty-somethings posting Minecraft videos on YouTube, and hundreds of millions for its reclusive, miserable founder. Trying to define what Minecraft is – or what prompted Microsoft to pay \$2.5 billion for it – is like trying to pin jelly to the wall.

Here we're going to give a broad snapshot of what's convinced 70 million people – both children and adults – to enter this brick-building phenomenon. We're going to explore why people play it, where it's headed, how long it's going to last and whether its new owner is looking after it properly. And then we're going to show you some of the most incredible worlds and contraptions built in Minecraft, to tempt you into joining them.



Famous landmarks are among the countless objects that can be modelled in Minecraft

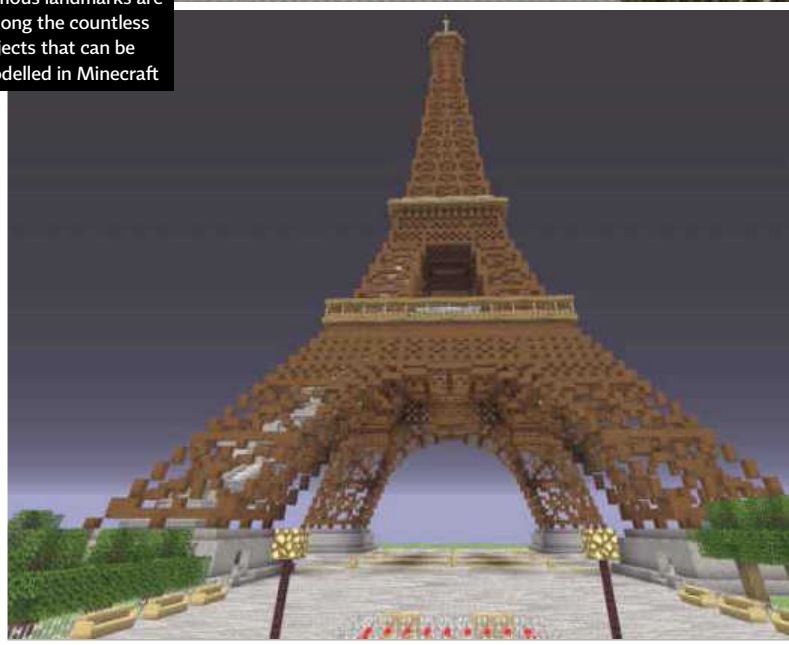
SURVIVE OR THRIVE

There is no one way to 'play Minecraft'. There are two main gaming modes – Creative and Survival – but hundreds of different ways to play each. Creative is the sandbox mode, where players are free to build whatever they choose – houses, farms, pirate ships, an ancient metropolis, the Eiffel Tower, models of molecules – from the hundreds of blocks and objects available. Imagine a massive box of Lego tipped out on the carpet and you're getting the gist.

Creative is, anecdotally, the mode most favoured by children, giving them free rein to build whatever their imagination dictates without the chore of having to find, mine and craft new resources. Players can build individually or as a team, through local multiplayer games or servers.

Survival is more of a grind, a challenge for those who are bored by the endless building and don't want everything handed to them on plate. You start with nothing, forced to bash yourself a shelter, forage for food and knock together some basic weapons before night falls and the spiders, zombies and iconic creepers come looking for you. The ultimate goal is to make it to The End – a desolate underworld where you must slay a dragon. However, despite the name, the game never actually 'ends' – even when the Ender Dragon is downed you're free to continue roaming through your Minecraft world.

Survival can be played solo or in multiplayer modes too, and again there's no end of variants. Huge player vs player (PvP) servers operate online with thousands of players chopping and hacking at one another. Twenty-strong clans roam maps, looking for hidden enemy bases in the sky or underground, always on the lookout for traps made using the in-game 'electricity', called Redstone. There are also gazillions of server mini-games, that turn Minecraft into multiplayer mazes, capture the flag or horse racing games.



Then there are the endless ways to adapt Minecraft. Players' skins (the costume worn by their avatar) can be customised; mods alter the way the game looks and feels, changing the appearance of blocks and introducing new rules or features to the game; resource packs re-skin the entire environment, turning your Minecraft world into a medieval kingdom or Christmas wonderland. There's an entire ecosystem built around all of these and a huge community willing to share their creations.

NOT JUST FOR KIDS

Anyone with children is probably used to wrenching the smartphone or tablet out of their hands, forcing them to perform trivial tasks such as eating and sleeping in between Minecraft sessions. A survey of 2,800 children conducted by the makers of the Dinner Time Plus app, which reports on kids' device usage, found that children spend an average of 52 minutes per day playing Minecraft.

But it's not only kids who are obsessed with Minecraft. The game has true cross-generational appeal. We invited members of the Minecraft subreddit (www.reddit.com/r/minecraft) to tell us why they played the game and the

A survey of 2,800 children conducted by the makers of the Dinner Time Plus app found that children spend an average of 52 minutes per day playing Minecraft



responses ranged from 18-year-old students killing time between lectures to retirees looking for a creative outlet.

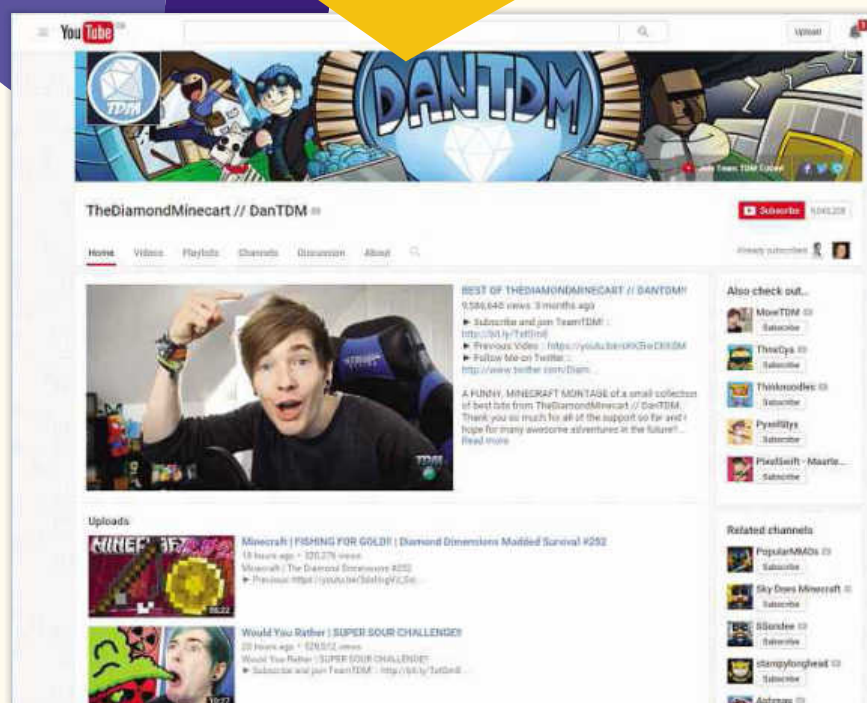
One 67-year-old player, who first started playing text-based games in the 1970s, told us he loved the sedate, open-ended nature of the game. "The variety of things to do and build is the most fun," he said. "I like collecting resources, farming, automation and on my current world have been building next to an NPC village [an in-game village inhabited by computer-controlled villagers] – kind of like the castles in the Loire Valley that have a small town outside to supply the castle with staff and supplies. I probably play about six-to-eight hours a week, sometimes more, sometimes (due to work) much less."

Another fifty-something player was one of the many who told us he had set up a home Minecraft server that several members of the family play on. "I have a custom modded family server running that the wife gets on once in a while," he said. "Actually we're waiting for our granddaughter to show interest in the game, at which point the wife and I may start a clean world for us to all share."

For some, the game has become a profession. Mark, a systems admin in his forties from Australia, says Minecraft has a unique appeal. "The thing about Minecraft is how true to being a sandbox it is," he told us. "Games generally have paths, some will railroad you. It's a pretty ride, but you tend to start at set-piece A and find yourself at set-piece B, then choose how to get to set-piece C, and so on. Minecraft doesn't really have that; you have to bring your game into it. The 'how' you play, and the toolset that is Minecraft, is one of the greatest strengths of the game itself."

He describes himself as a "professional streamer" on Twitch.tv – a site devoted to live streaming of people playing games – and has more than 160,000 followers, predominantly watching videos about modified versions of Minecraft. "I make packs, test my own and others, [and] share my 'moments' with thousands," he said. "I use the word 'moment' specifically. Minecraft allows me to create moments. Interesting and in-depth, dangerous and thrilling, humorous and educational. And sometimes, I just want to build a machine that can do, well, nearly anything."

Then there are those at the opposite end of the spectrum, who treat Minecraft like a creative hobby. "I find



↑ DanTDM, also known as TheDiamondMinecart, is a YouTube channel operated by Daniel Middleton. It's centred around Minecraft and has over 9m subscribers

it meditative," said a 36-year-old respondent who introduced his daughter to the game, not the other way round. "I usually play while listening to podcasts or audiobooks. I can kill two birds with one stone that way. Also, I consider it an art form. It might seem a strange medium for many, but I really enjoy it. It is digital sculpture."

And, perhaps most upliftingly of all, there are people who've found an outlet in Minecraft that they couldn't find in the 'real world'. "I started playing in high school... but I continue to play because of the friends I have made and the community I'm part of quite literally saved my life," wrote one Reddit respondent. "I suffered from depression and struggled with suicidal thoughts daily. Luckily I had a second home full of people who really and truly cared for me, a place where I could talk and be myself, a place I felt safe, a place I controlled. That is something I can never forget and that's why I continue to play."

Another player in their mid-30s told us they too use the game to deal with a mental disorder, although this time seeking isolation rather than company. "I play because I have social anxiety that I have to keep under wraps all day in order to function in human society," they told us. "Sometimes when I get home all I want is to be alone in a giant empty world with no-one in it."

Closer to home, the Shopper team played Minecraft every lunchtime for some time, showing the kind of cooperation and coordination that allows us to create a monthly magazine to exacting deadlines without fail. Well, that's how it started anyway, before a huge schism occurred in the team between those who wanted a simple agricultural life and those who wanted to craft a huge mountain-top ziggurat to access other planes of existence. A war of sabotage began and we shut off the server before everyone fell out irreconcilably.

↓ Trading and building with villagers is just one of the many Minecraft challenges





EVOLVING WORLD

Another factor that keeps people coming back to Minecraft is that the game is continually evolving. First released in beta in 2009, Minecraft finally reached version 1 in 2011. Since then, there have been nine major revisions of the PC game, culminating in the recent release of Minecraft 1.9 – the so-called Combat Update – which brings a barrage of new features, including the ability to use items in both hands for the first time and various tweaks and enhancements to the in-game weaponry.

Each new version is released as a free update – if you paid for Minecraft 1.0 back in 2011, you've never needed to pay for a PC version of the game again. (It will be interesting to see how long parent company Microsoft maintains this revenue-free approach, but more on Microsoft later.) Of course, developer Mojang has found other ways to keep the money coming in. The Pocket Edition is a permanent fixture in the iOS and Android charts, and there's a bastardised version for Windows 10; there are versions for Xbox and PlayStation and a belated arrival on the Wii U in prospect, as well as editions for the Mac and even the Raspberry Pi.

Minecraft has many imitators. A casual glance through the App Store reveals dozens of titles, such as 'MC Block Mega Builder Mini' or 'Build IT Craft' or 'Infinity Craft' – naked, cut-price rip-offs that often manage to tempt enough gamers to briefly flash into the charts and make

Each new version is released as a free update – if you paid for Minecraft 1.0 in 2011, you've never needed to pay for a PC version again

↑ Minecraft Pocket Edition is a permanent fixture in the app store charts

↓ Minecraft only made it into the Windows Store after Microsoft bought the company

their developers a quick buck. The closest genuine rival to Minecraft is Terraria, a 2D-scrolling adventure sandbox that contains many of the same elements as Minecraft: crafting, mining and even a lead character wielding a Minecraft-like pickaxe. Terraria has reportedly sold over 12 million copies on Windows, the consoles and app stores, but that's still dwarfed by the 70m+ sales of Minecraft.

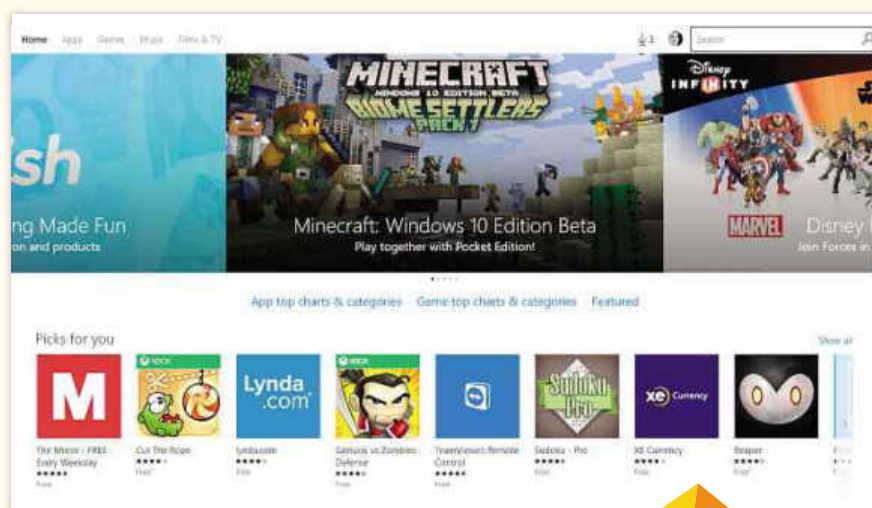
In fact, Minecraft is in such a league of its own that it has started branching out into other genres. The recently released Minecraft: Story Mode is a children's point-and-click adventure of the Monkey Island ilk, although far less satisfying. It's topped the app charts, too, though hour-long episodes that cost £3.99 a pop are rubbing players and their parents up the wrong way, judging by the tepid reviews.

NEW PARENTS

Indeed, that kind of exploitation of Minecraft's loyal fan base is exactly what many people feared when Microsoft shocked just about everyone by buying Mojang for \$2.5 billion in 2014. It's hard to imagine two more different cultures. Mojang was a small Swedish developer that was loved by the Minecraft community for its open approach and sheer quirkiness; Microsoft was the starch-collared corporate behemoth that predominantly believes in closed code and only engaging with its customers if six lawyers and a press officer have read the blog first.

Mojang CEO Markus Persson – known as Notch in Minecraft circles – had previously slated Microsoft, refusing to deliver a version of Minecraft for the Windows 8 Store because of the way the company forced developers to certify their apps. "I'd rather have Minecraft not run on Win 8 at all than to play along," he tweeted. "Maybe we can convince a few people not to switch to Win 8 that way."

Within 18 months Persson was reportedly knocking at Microsoft's door to sell his company. His apologetic post-sale blog stated: "I'm aware this goes against a lot of what I've said in public. I have no good response to that." And while Mojang has been absorbed into Microsoft with less enmity than many expected, there's clearly lingering resentment from Persson's former staff. "When we sold the company, the biggest effort went into making sure the employees got taken care of, and they all hate me now,"





Minecraft could be the killer app for Microsoft's HoloLens

Persson tweeted in August, in a series of posts complaining about the loneliness of his new life as a carefree billionaire.

Yet, even if Notch remains miserable, the general consensus is that Microsoft has done a pretty solid job with Minecraft so far. Of course, Microsoft ensured that Minecraft made it to the Windows Store, but it did so by giving away a free copy to owners of the existing PC version and has shown no signs that it's about to exploit Minecraft as a Windows 10/Xbox exclusive. Indeed, Mojang recently announced it was bringing the game to Nintendo consoles for the first time, and has continued to provide meaningful updates for the Pocket Edition on Android and iOS.

Microsoft has largely stayed out of view as far as Minecraft is concerned – in public, at least. Mojang continues to run as a separate entity from Stockholm. At last summer's Minecon event in London – attended by 10,000 Minecraft fans – there was barely a Microsoft logo in sight.

"Microsoft is well on the way to proving that there should be no fear with a Microsoft-owned Minecraft," said Patrick Moorhead, president and principal analyst of Moor Insight, who attended Minecon. "The thing Microsoft needs to keep in mind is that it needs to stick to the same way of managing Minecraft or risk damaging the property or alienating the community. I say community because Minecrafters truly have a mind and personality of their own where it's not about individuals, but the collection of them, that makes them a community."

HOLD FUTURE

So what on earth tempted Microsoft to pay £2.5 billion for Mojang? Sure, Minecraft's a consistent top-seller, and regular updates for the Xbox One

won't hurt, but it doesn't sell anywhere near enough to justify such an enormous price tag on sales alone. And though Mojang does develop one or two other titles, they are near insignificant.

The real reason Microsoft was desperate to get its hands on Minecraft was to give it a killer app for arguably the biggest gamble in the company's entire history: HoloLens. The company's announcement of the holographic headset in 2015 caught more people by surprise than the decision to buy Mojang, and Microsoft has already delivered some spectacular demonstrations of how HoloLens and Minecraft will come together.

A Microsoft keynote at the E3 games conference showed the enormous potential, with the company's HoloLens-wearing presenter able to open a Minecraft world on the ordinary (real) table in front of him. The audience – seeing what the Microsoft man could see on the big screens, courtesy of a specially adapted camera – gasped as the blocky mountains erupted out of the table's surface. The demonstrator could manipulate blocks with his hands, swing round to change the view, peer into buildings or beneath the surface. Better still, he could continue playing in the same world as his colleague using an ordinary Microsoft Surface tablet – HoloLens players won't be siloed from the rest of the Minecraft community.

HoloLens is expected to launch this year, and if Microsoft manages to tempt even a fraction of the 70m Minecraft players into popping on a headset and building a city on their tables, that \$2.5 billion price tag might not look so daft after all. We can't say the same for the person wearing the headset, mind...

WHERE TO BEGIN

Minecraft website

Official site to download the PC game, plus links to many useful apps and community sites: minecraft.net

The Minecraft Wiki

A comprehensive database of everything you use, build and interact with in Minecraft: minecraft.gamepedia.com/Minecraft_Wiki

Mineworld

Our new magazine packed with tips and tutorials. Pitched at kids, but useful for mums and dads, too: www.dennis.co.uk/brands/mineworld

MOST AMAZING MINECRAFT WORLDS



THE HEIST

tinyurl.com/338minecraft1

The Heist is a terrific example of how it's possible to build standalone games within Minecraft. This immaculately made espionage adventure has you ducking past security cameras, seeing through walls with your x-ray vision and hacking into computers. There's none of the normal Minecraft mechanics of building and crafting; you just bundle through the linear levels, trying not to raise the alarm and alert the guard robots.

THE TITANIC

tinyurl.com/338minecraft2

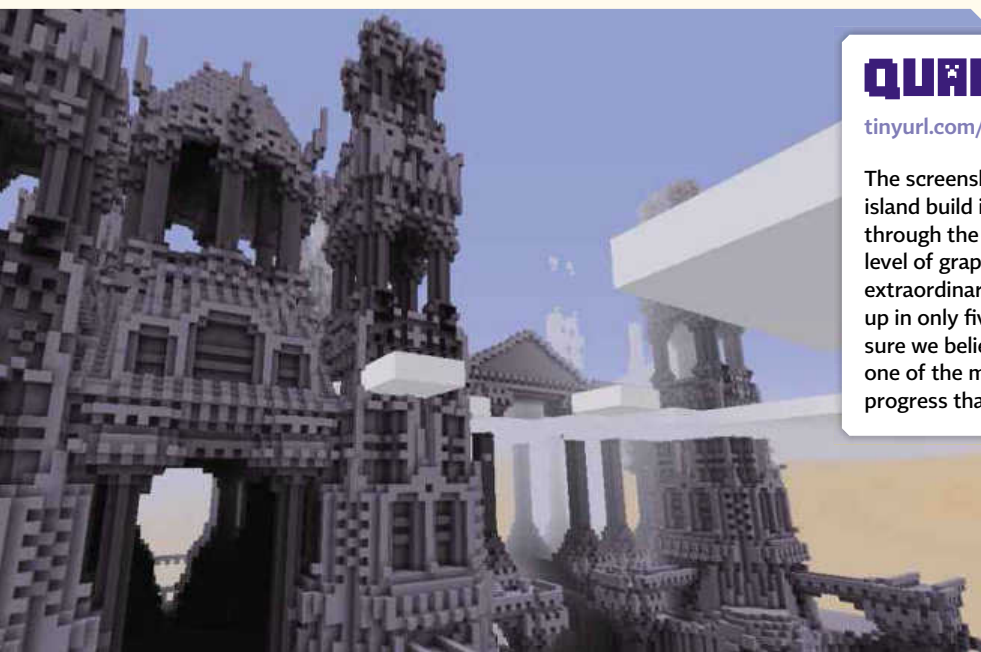
Claimed to be the "most detailed Titanic out there", this massive feat of shipbuilding took a year to complete, according to the charmingly named builder, Deadkoalas. We know that's his name, as he's plastered it on signs all around the ship, but we'll forgive his aggressive claim for credit because the downloadable build is remarkably detailed, from the train journey to the ship when you first land, to the individually marked cabins and stores down below. This one's truly unsinkable, too. It can't move.



QUARTZ CASTLE

tinyurl.com/338minecraft3

The screenshot barely does justice to how big this castle island build is. It's an enormous gothic build that pokes through the clouds – you'll need a PC with a reasonable level of graphical poke just to take it all in. Even more extraordinary is that its creator claims to have knocked it up in only five hours when bored at Christmas. We're not sure we believe him. The castle is an empty shell, which is one of the many reasons we like this build: it's a work in progress that offers scope for your own adaptation.



TITAN CITY

tinyurl.com/338minecraft4

An epic modern metropolis, Titan City is the sum total of two years of its maker's life. It's like taking a walk through Canary Wharf: there are enormous, varied skyscrapers wherever you look. Its maker, YouTube user Colonial Puppet (www.youtube.com/user/ThomBrockGaming), should be snapped up by architects, such is the variety and excruciating amount of detail in the build, which comprises 4.5m blocks. It's free to download and there's plenty of scope to adapt the designs yourself.

MY MOTHER'S HOUSE

tinyurl.com/338minecraft5

A great example of a more cerebral build, My Mother's House is Victoria Bennett's ode to her dying mother, an interactive poem that unravels as you walk around the various rooms. The poetry is delivered in many forms: sometimes the narration kicks in as you move from room to room, sometimes it's displayed in text, sometimes the poems are tucked inside books hidden in Minecraft chests. The build is extraordinary enough in its own right, but the moving poetry is equally enthralling.

WESTEROSCRAFT

tinyurl.com/338minecraft6

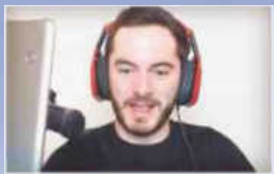
A staggeringly complex re-creation of the Seven Kingdoms, WesterosCraft pays glorious tribute to George RR Martin's *Game of Thrones*. The map is massive and hugely demanding: you'll need dedicated graphics to make the most of it. It has all of the main locations from the books and television series, including King's Landing, Winterfell and Castle Black, among others. Join the multiplayer server and start exploring – it's bewildering how few people are playing this incredible build.

INCREDIBLE REDSTONE CONTRAPTIONS

THE VIDEO PHONE

tinyurl.com/338minecraft7

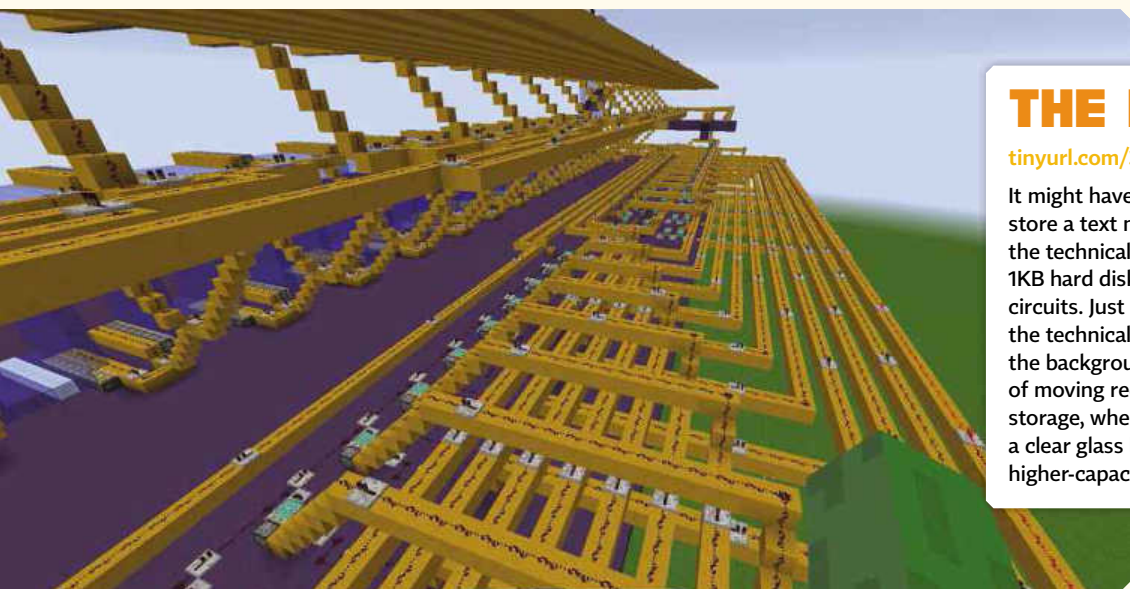
This project, sponsored by the US mobile network Verizon, re-created a working smartphone within Minecraft, capable of making and receiving video calls. Each of the screen 'pixels' is a regular Minecraft block, although it's fair to say the screen isn't exactly Retina resolution. The phone was built using a web app called Boxel to translate web pages and streaming video into Minecraft blocks that can be rendered in real time.



THE HARD DISK

tinyurl.com/338minecraft8

It might have only enough storage space to store a text message, but don't underestimate the technical achievement of building a working 1KB hard disk using nothing but redstone circuits. Just one look at the screenshot reveals the technical complexity of what's going on in the background. The creators used thousands of moving redstone pistons to create the storage, where a solid block represented a 1 and a clear glass block a 0. Others have since built higher-capacity drives.



THE PLAYABLE GUITAR

tinyurl.com/338minecraft9

You won't be picking the solo from Layla on this working redstone guitar, but you can nonetheless change the chords by simply moving your character. This hugely complex build uses redstone pressure plates – normally used to open doors when your character steps on them – to create the guitar version of the massive piano Tom Hanks plays in *Big*. The link to download the guitar is found in the description of the YouTube video link above.

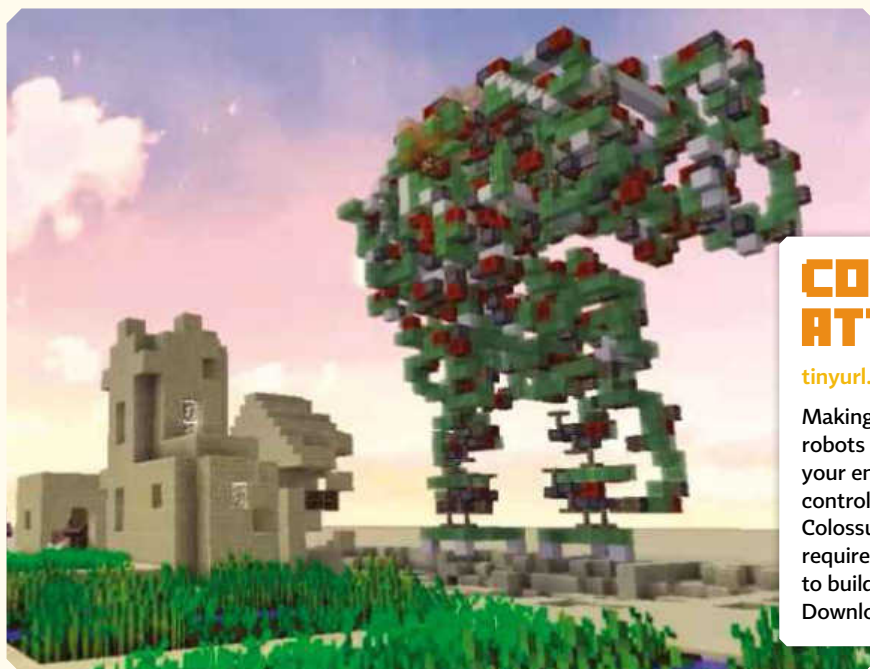




SPAGHETTI ROLLERCOASTER

tinyurl.com/338minecraft10

Rollercoasters are a common use for redstone – the Minecraft ‘electricity’ is used to power a minecart around the tracks. Few rollercoasters are as intricate and varied as this monster, which won second prize in a competition on the Planet Minecraft website, where many people share their builds. It’s a winner for us because it doesn’t only use redstone to power the carts, but for mini-games and fireworks that appear as you shuttle around the track.




COLOSSUS WALKING ATTACK ROBOT

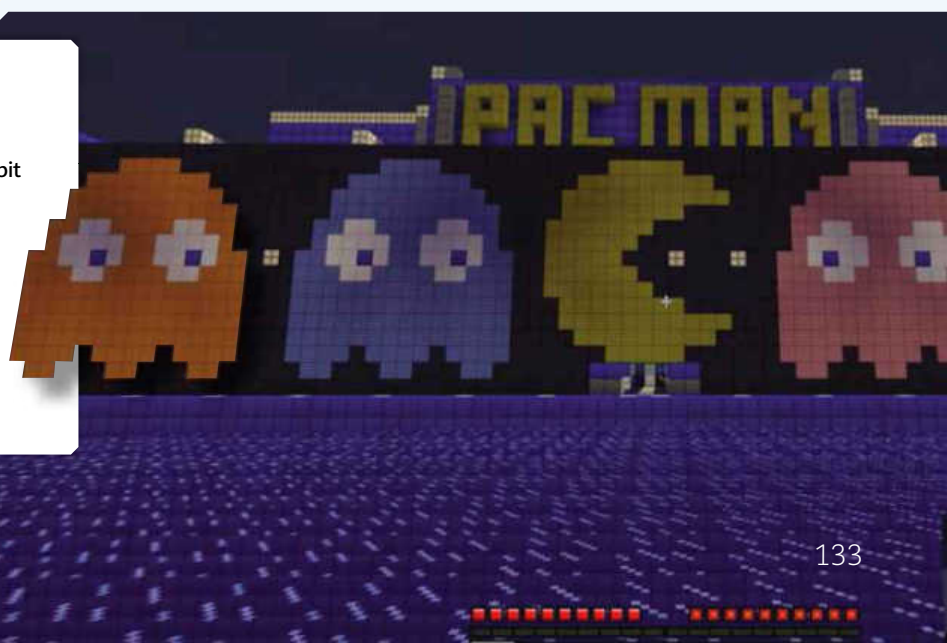
tinyurl.com/338minecraft11

Making things that move in Minecraft isn’t easy. Making massive robots that stomp across the landscape dropping TNT bombs on your enemies is something else. The makers of this massive, controllable beast claim it took more than 50 hours to build Colossus, and you can see why: it’s a mass of moving pistons that requires an incredible amount of engineering skill. They even had to build a redstone elevator to get the player into the beast. Download using the link in the video description.

PAC-MAN

tinyurl.com/338minecraft12

Like the game itself, this Pac-man build is getting on a bit now – but it’s still one of the most amazing uses of redstone we’ve seen. There are no ghosts or Pac-man himself, despite the visuals. Instead the game sends your character running around a maze, collecting gold nuggets (instead of pellets) and trying to avoid zombies, skeletons and other Minecraft foes. A vast number of redstone pistons and droppers control the action, and there are even selectable difficulty levels, chosen by flicking redstone levers. 



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How do I make document comments larger?

Q Because my eyesight isn't what it used to be, I need the text size in my documents to be large. However, things such as comment balloons always reset to a small font size.

I know how to change the font, but my problem is that because I use a low screen resolution, the Apply button isn't visible on the screen, and I have to change the orientation to portrait to view it. Is there a way to permanently alter the font size for the comments? I work on many different documents from a wide variety of sources.

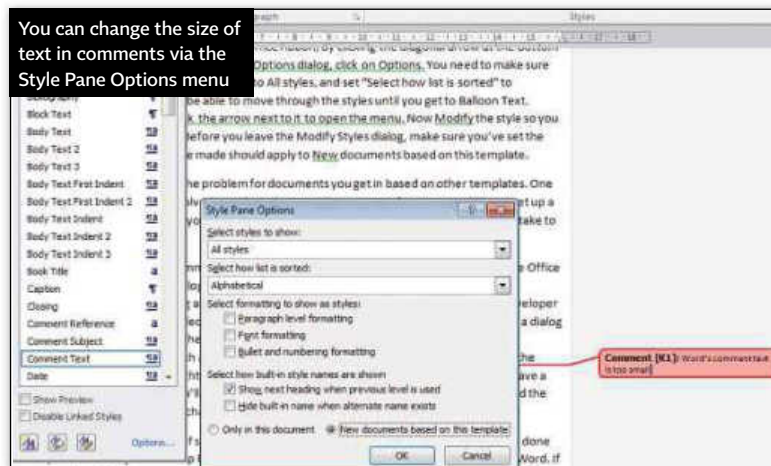
Charlotte Graves

A The first thing you can do is to make sure the comment font size is set to the size you want in documents by modifying the default template settings. To do this, create a new document, and open the Styles pane by typing Alt-Ctrl-Shift-S. You can also do this from the Styles group on the Home tab on the Office ribbon, by clicking the diagonal arrow at the bottom right of the Styles group. In the Style Pane Options dialog, click Options. Make sure the 'Select styles to show' choice is set to All styles, and set 'Select how list is sorted' to Alphabetical. You should now be able to move through the styles until you get to Balloon Text. Right-click the name, or click the arrow next to it to open the menu, and modify the style so you have a large enough font. Before you leave the Modify Styles dialog, make sure the changes you've made apply to new documents based on this template.

However, this won't work for documents you receive based on other templates. One way to avoid making the same change time after time would be to set up a macro to run when you press a particular key combination. The steps you need to take to do this are as follows.

Open a document that has comments in the wrong size. If you can see a Developer tab on the Office toolbar, click it. If the Developer isn't visible, you can make it visible using File, Options, Customize Ribbon, and putting a tick next to Developer in the list of Main Tabs. Once the Developer tab is visible, click it and select Record Macro from the Code area of the ribbon. You'll see a dialog appear in which you can give the

You can change the size of text in comments via the Style Pane Options menu



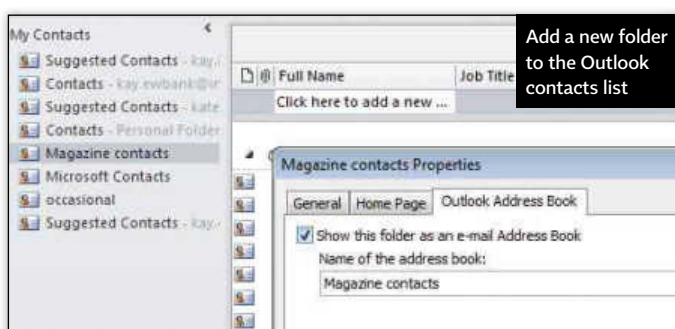
macro a suitable name (BigComment, perhaps?) and, more importantly in your case, attach a keyboard shortcut to it. This will be your way of accessing the macro in the future, and it might be a good idea to write down the key combination so you have a chance of remembering it. You'll see that the normal cursor has changed to be a cassette, and the Record Macro menu item has changed to stay 'Stop Recording'.

Now work through the steps of solving the problem in the size of the comment. Once you've done that, click on the option to Stop Recording. You can now close the document, and also close Word. If you're asked whether you want to save changes to the template, answer Yes. You can now restart Word, and try opening a document that has problems with the comment size. When you get to the comment you want to alter, press the keyboard shortcut and you should find the changes are made without you having to fiddle with altering the screen layout.

Importing contacts into Outlook

Q I've recently begun using Outlook 2013, and I've imported my list of contacts from a text file. I can now see a list that appears to be the new people I imported at the bottom of my other contacts. However, when I attempt to write an email and press the To: button, the contacts aren't there. I see an empty address book, and no matter which option I choose no contacts are available.

Dan Brentford



A One likely reason is that when you imported the contacts, they were put into a new contacts folder. If you look in People (or in earlier versions in My Contacts), you'll see the list of contacts folders for your profile. The one Outlook pulls the email addresses from is usually called Contacts. You can either move your new contacts into the main contacts folder, or you can specifically tell Outlook that you want the other contact folders to be available for use when emailing.

To do this, select the folder that contains the new contacts you've just imported, right-click it, and select Properties. Select the tab that's labelled Outlook Address Book, and put a tick in the box labelled 'Show this folder as an e-mail Address Book'. Click OK, and when you next create a new email and click the To: button, you should find that the new contacts folder is displayed in the drop-down list so you can choose a contact from it.

Grabbing data from a website automatically

Q I have a spreadsheet that I use to monitor information pulled from web pages for our company. Every day I need to go to the same set of websites, and pull data from them – essentially product name, product code, colour, and price. I enter a web address that includes the product code of a particular item, so that I see one item at a time. I then manually copy and paste the data into my spreadsheet, then copy the parts I need from my 'paste zone' to the locations in my product table.

This is quite time consuming, particularly when I have to do it for dozens of items. I'd like to automate the process, but I don't know anything about macro programming. I have tried using the command to Get Data from Web, but that brings across everything on the page, which isn't what I need.

Graham Steed

A The macro below assumes your list of URLs includes the product code in column C, along the lines of www.website.com/product_identifier/p/p12345678, where the product code is p12345678.

You'd have your list of URLs in column C, and the macro would extract the product name, ID and price into columns D, E and F. The macro assumes the data starts in row 2 and ends in row 10; you'll need to change the values in LastRow = 10 and StartRow = 2 to the actual values for your data. You'll also need to change the sheet name.

The macro pulls data from a web page by crawling it, and you should check that the owners of the site are OK with you crawling their site and extracting data. Make sure you've referenced both the Microsoft HTML Object Library and the WinHTTP library.

```
Sub GrabWebData()
    Dim GetRow As Long, LastRow As Long,
    StartRow As Integer, TotalRecords As
    Long
    Dim httpreq As New WinHttpRequest,
    htmldoc As New HTMLDocument, htmlele As
    HTMLHTMLElement
```

```
Dim Url As String, ProdName As String,
Price As String
Dim wb As Workbook, ws As Worksheet
Set wb = ThisWorkbook
Set ws = wb.Worksheets("YourSheetName")
ws.Activate
LastRow = 10
StartRow = 2
```

```
For GetRow = StartRow To LastRow
```

```
    Url = ws.Range("C" & GetRow).Value
    httpreq.Open "POST", Url, False
    httpreq.send
    htmldoc.body.innerHTML = httpreq.
    responseText
```

```
    For Each htmlele In htmldoc.
    getElementsByTagName("span")
        If htmlele.ID = "ProductName" Then
            ProdName = htmlele.innerText
            Exit For
        End If
    Next htmlele
```

```
    For Each htmlele In htmldoc.
    getElementsByTagName("span")
        If htmlele.ID = "UnitPrice" Then
            Price = htmlele.innerText
            Exit For
        End If
    Next htmlele
```

```
ws.Range("D" & GetRow).Value = ProdName
ws.Range("E" & GetRow).Value = Price
```

```
    ProdName = ""
    Price = ""

    Next GetRow
    MsgBox ("finished")
End Sub
```

The key parts of the macro are first the use of the WinHttpRequest, HTMLDocument, and HTMLHTMLElement. These are used to send the request for the web page and to hold the HTML returned by the request:



↑ You can view HTML in web browsers to see the data you're attempting to locate from VBA

```
Url = ws.Range("C" & GetRow).Value
httpreq.Open "POST", Url, False
httpreq.send
htmldoc.body.innerHTML = httpreq.
responseText
```

The For Each loops then go through the HTML document looking for relevant tags. Knowing what tags you're looking for is the key here. I'd recommend first looking at the underlying HTML used by the website you're working with. You can view the underlying HTML by right-clicking it in your browser and choosing the appropriate command: View Page Source in Firefox or Chrome, and View Source in Internet Explorer. You can then look through the HTML to find the data you want.

The sample website you specified in your question stores the data using tags, but other sites might use <p>, <meta>, or other tags. Your data might also be buried inside other information within a tag, so you might need to do some text extraction.

Once the correct data has been located, it's copied to the cells using:

```
ws.Range("D" & GetRow).Value = ProdName
ws.Range("E" & GetRow).Value = Price
```

How can I get the most recent data?

Q I'm using Access to keep inventory data, and I need to produce a report that shows the most recent inventory level for each product. I've tried creating a query that finds the most recent date for each product, but I can't see how to tie this to the inventory amount to get that as part of the output.

Laura Tunstall

A The answer is to use two tables. The first finds the most recent entry for each product. Give this a name such as qryMaxDte:

```
SELECT Max(ProdTab.ProdDate) AS MaxDate, ProdTab.ProdID
FROM ProdTab
```

```
GROUP BY ProdTab.ProdID
```

Then you use this query in a second table, joining it to the original:

```
SELECT ProdTab.*
FROM ProdTab INNER JOIN qryMaxDte
ON (ProdTab.ProdID = qryMaxDte.ProdID)
AND (ProdTab.ProdDate = qryMaxDte.MaxDate)
```

The first query gets you the most recent record by date for each product; the second query uses an inner join to pull the rest of the information. You can then use this however you wish. **CS**

Helpfile

Whatever your general PC, hardware and software woes, **Simon Handby** is here to help. Send your problems to help@computershopper.co.uk



Unstable since Windows 10 upgrade



I have two computers: a laptop, and an Eclipse desktop with an Asus P8Z77-V LX motherboard, two SSDs, two hard disks and an Nvidia GeForce GTX 750 Ti graphics card running three monitors. Both PCs ran Windows 7 Home Premium. I upgraded the laptop to Windows 10 to test it out before upgrading the desktop PC, which I mainly use for MS Flight Simulator X. The upgrade of the laptop went quite well, but the desktop has been a tale of woe.

As briefly as possible, the upgrade wouldn't even start due to a partition issue which I had to fix with the EaseUS partition manager. Then the update froze in the 'setting up' phase, after which I had to restart the PC. The upgrade seemed to have completed, but since then barely a day has gone by when Windows 10 hasn't crashed or suffered some critical event. The crashes got more frequent until the PC wouldn't even boot into Windows; fortunately my son was able to repair the master boot record, which got everything back up and running again.

My joy was short-lived, though. Since then I've been beset by software failures, critical events and blue screens of death (BSODs). Windows would often report that it hadn't shut down properly, when I had watched it do so the night before. I noticed that Windows Defender stopped working from time to time, seemingly after a failed attempt to update.

I have wondered if the PC might have a virus, and tried a scan with Defender and Trend Micro. I subsequently followed your suggestion to run Malwarebytes' Anti-Malware, which caused a BSOD with a memory management fault. When it completed it showed three items, all related to OpenCandy. I tried to run it again from Safe Mode and got another BSOD.

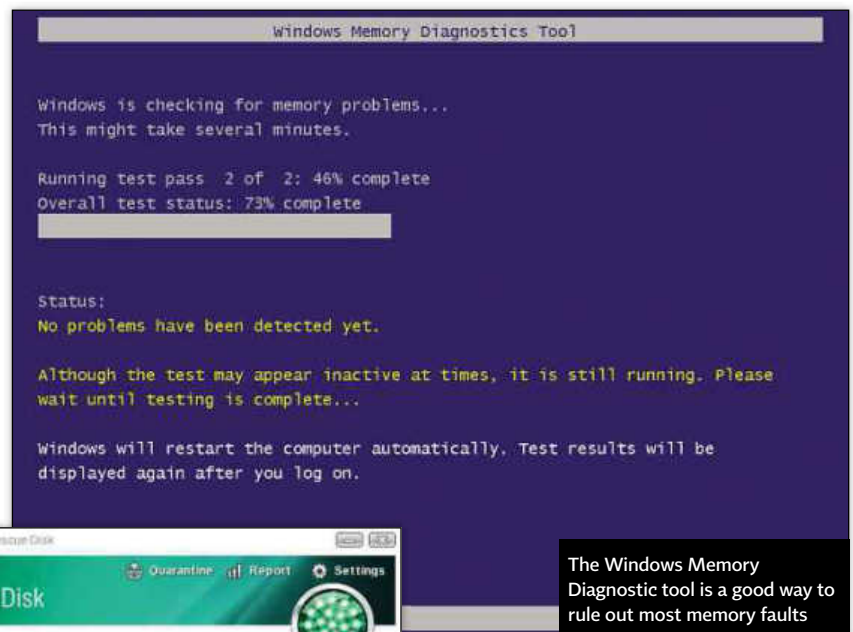
I don't think it's an issue with overheating: Flight Simulator X tends to run quite stably, and the Asus system monitor currently reports CPU and motherboard temperatures of 36°C and 27°C. Furthermore I vacuumed the inside of the PC recently to remove any fluff from fans, grills and so on.

I would be most grateful if you could suggest any memory or system diagnostics that might shed some light on the issue.

Richard Sanders



We've heavily abridged your long-running tale of woe for publication. Your issue has involved so many faults, seemingly at random, that we first wanted to completely rule out a virus infection and a memory fault. After the Malwarebytes scan, we suggested that you run Kaspersky's free TDSSKiller anti-root kit utility,



The Windows Memory Diagnostic tool is a good way to rule out most memory faults



↑ Create the Kaspersky Rescue Disk from a PC you know to be clean, then boot from it to search for malware

and also boot from and run the free Kaspersky Rescue Disk. We also suggested you search the Start Menu for 'memory', then run the Windows Memory Diagnostic.

Given that these tests failed to show up a clear issue, it seemed likely that the Windows 10 installation was fundamentally corrupted in some way, and one option was to re-install from scratch. Unfortunately, this didn't fix the problem either.

One remaining issue is the possibility of an instability with your Asus motherboard which only manifested itself with the move to Windows 10. Indeed, looking at the BIOS history for the P8Z77-V LX does reveal a great number of releases, many of which cite system stability improvements. With this in

mind we'd strongly recommend that you download and upgrade to the most recent version (2501), but that you don't under any circumstances do so from within Windows – a BSOD during the BIOS flashing process could render the motherboard unusable.

Visit the Asus support site and download the latest BIOS version, then save the unzipped BIOS file to a USB flash drive formatted with the FAT or FAT32 file system. Leave the disk inserted and reboot the computer, then hit Delete as the BIOS screen is displayed to get into the BIOS. From the Tools menu run EZ Flash 2 and navigate to the USB drive to find the file you downloaded. Before performing the update, double-check that the new BIOS is a newer release than your existing one, and that the motherboard information matches.

What the £#@”?

Q I updated my Sony Vaio laptop to Windows 10, following the excellent guide in *Shopper*. The only problem I have is that the @ and “ keys have become reversed, and the hash key now produces a backslash; the backslash key works correctly. The pound key now types the hash sign, and trying to type a tilde produces the pipe. Again, the pipe key itself works correctly.

I assume the keyboard is corrupted, but I can't find where I can check the keyboard language settings. I've checked for updates in Device Manager, but that reports that the correct driver is installed. Any help you could offer me would be greatly appreciated.

Percy Leeman, percy.leeman@mail.com

A It sounds as if the keyboard type or language is set incorrectly. Try opening the Start menu and typing 'keyboard' (without the quotes), then running the Keyboard Control Panel app in the results. Check that you have United Kingdom in the Country or region field, and English (United Kingdom) under Languages. Now click on

Additional date, time & regional settings and under Language click Change input methods. Check you have English (United Kingdom). If it isn't top of the list, click once to highlight it then click Move up until it's at the top. Click Options (towards the right of the list) and check the input method is United Kingdom.

Accessing these settings has changed slightly in the latest update to Windows 10 (see 'Windows 10 falling behind?', right). If you're running build 10586, search the Start menu for Region, then open Region and language settings and follow the steps above.



No room for Windows 10

Q I recently upgraded my laptop to Windows 10 and have been happy with the changeover. I now wish to upgrade my PC but understand that I'll need about 16GB of free hard disk space. My current Windows 7 operating system is installed on a 60GB SSD which has only 1GB free. I've tried to clear some space on this to no avail, so I suspect the best solution would be to buy a new SSD of at least 120GB, and transfer everything from the existing SSD to the new one and then update to Windows 10.

Can you advise me of the steps I need to take to transfer the data to a new SSD?

Pete Fincher, pete.finch@talk21.com

A You haven't detailed what you've tried in order to free up disk space. If you haven't already, use the Disk Cleanup utility: you can find it by searching for disk clean in the Windows 7 Start menu. Make sure you choose to clean up system files when you see the option.

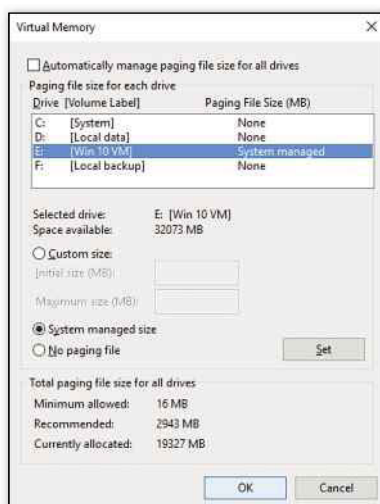
It's unlikely you'll free up 15GB through Cleanup alone. You may free up more space by disabling hibernation: open the Start menu, search for 'CMD' (without the

quotes), right-click it in the results and select Run as administrator. At the prompt type powercfg.exe /hibernate off and press Enter. You can re-enable this by following the same steps but typing powercfg.exe /hibernate on.

If you have a second disk in the PC, you may be able to free up still more space by changing the swap file settings: open the Control Panel, search for System and click 'Edit the system environment variables'. Click Settings (under the Performance heading), select the Advanced tab, click the Change... button, then untick Automatically manage paging file size for all drives. Select drive C: in the list, select No paging file, click

Set, then select your other disk, choose System managed size and click Set, then click OK and reboot when prompted.

If that doesn't free up enough space and you're going ahead with buying a new SSD, the best option is to clone the existing SSD to the new one using suitable software. Some Crucial SSDs come with Acronis True Image HD, but if you have True Image backup software you can use the Bootable Rescue Media Builder to make a bootable USB flash disk, which contains the Clone Disk utility.



↑ Moving the page file can free up several gigabytes of disk space

Windows 10 falling behind?

Q I upgraded my PC to Windows 10 in October. It generally works fine, but I recently discovered there's been an updated version since I upgraded, and Windows Update hasn't installed it automatically. I'm getting other updates with no problems, but no matter what update settings I try I'm stuck on version 10240. How can I force my PC on to the latest version?

Adrian Clark

A The so-called 'Fall update' released in November 2015 contains quite a few tweaks and minor improvements. It should have been installed automatically by Windows Update, but on many machines this hasn't happened. You can check which version of Windows you're on by opening the Start menu, typing winver and hitting Enter: build 10240 was the original release, while the latest version is 10586.xx (the last two digits depend on the patch level). If you're still within the one-month revert period after upgrading from an earlier Windows release, installing the Fall update will destroy your ability to revert to your original operating system.

If you're stuck on 10240 and want to upgrade, first run the Windows Update Troubleshooter at tinyurl.com/338help1 to check that Windows Update is working. If your PC still doesn't update automatically, go to tinyurl.com/338help2, click Download tool now, and upgrade using the Windows 10 Media Creation Tool. You'll see a 'ready to install' screen that doesn't mention an update: don't worry, if the installer is set to keep your personal files and apps it's safe to proceed.

With this upgrade, Microsoft appears to have removed the secdrv.sys service used by SafeDisc copy protection on some older games. If you're following our earlier advice to enable this temporarily on a per-session basis, build 10586 will block the workaround and render the games unplayable. It may be possible to circumvent the copy protection on games you own by downloading cracked versions, but you'll be opening yourself up to malware. A more involved but less risky solution would be to create a virtual XP machine in Windows 10 (see *Helpfile*, *Shopper* 334) and use the VM to run your games.



Creating smoke photography

A camera, a couple of flashguns and some incense are all it takes to create stunning abstract photos. **Ben Pitt's** house will never smell the same again



THIS ARTICLE WAS inspired by a blog post by Paul Bonnicksen (see tinyurl.com/CSsmoke). In it, Paul describes how he creates beautiful, abstract images with minimal equipment and a little patience. It inspired us to have a go, and you can see the results in this article.

These photos are sometimes recognisably smoke-like. Others look like flowers, shells, silk sheets, x-rays of bones, landscapes, humans, dolphins or aliens. For us, they work best when they straddle the divide between abstract and figurative. We also like the interplay between simple, repeating patterns and the complexity of chaotic movement. It's possible to exert some control over the shape of the smoke, but it's often the unexpected shapes that turn out best.

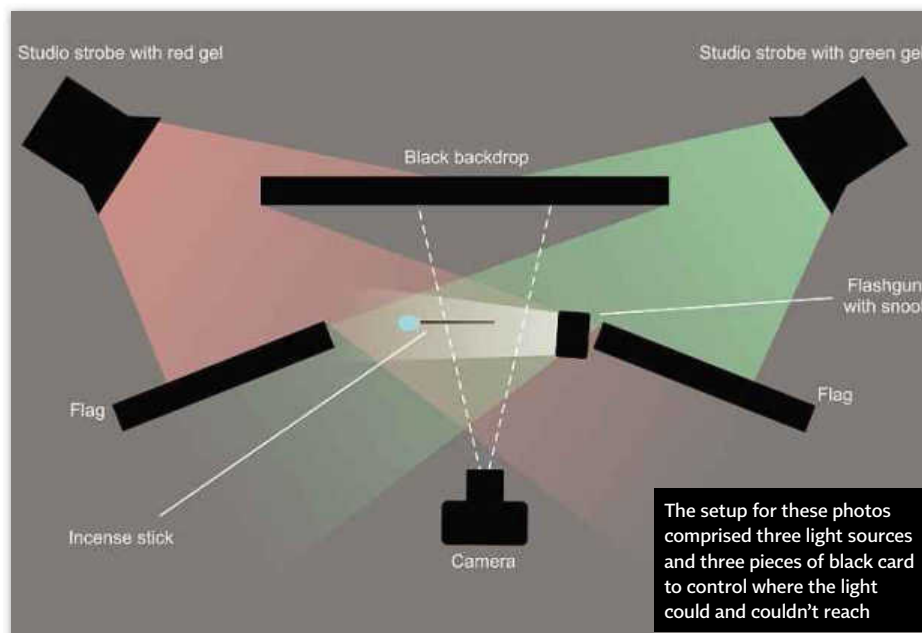
FLASH OF INSPIRATION

Smoke photography requires an off-camera flash system. This needn't be expensive, and there are lots of other times when it will come in useful. You'll also need a camera with a hotshoe in order to trigger the flash or flashes. Manual exposure control is essential, and you'll get far better results by shooting in Raw and processing images in Lightroom, Photoshop or another Raw-editing app.

A macro lens is useful but not essential. We used a Panasonic 14-140mm lens at the full zoom extension, positioned 50cm from the subject, but found we had to zoom out a little to get the best compositions.

Some cameras, such as the Canon EOS 750D, include wireless flash support, but this requires compatible Canon flashguns, which can be expensive. We've been using a pair of cheap Yongnuo flashguns and iShoot wireless triggers for the past six years. Considering they cost £95 for two of each, it's amazing that they've lasted so long and without any reliability issues. Unlike most big-brand flashguns, these low-cost models don't support automatic exposure and evaluative metering. Instead, we simply set the flash power on the back of the flashgun. However, for studio photography this is usually the best way to work. Search for 'flashgun' on Amazon and you'll find plenty of choice, with prices starting at £25. Flashguns are available from photography shops and from more established brands such as Sigma and Metz, with prices starting at around £60.

Flash power is measured as a Guide Number, or GN, which tells you how far away



a subject can be if shot with an f/1 lens at ISO 100. Chances are you don't have an f/1 lens, so divide this stated distance by the aperture value to calculate the true range of the flash. For smoke and other macro photography you'll want to use a narrow aperture of around f/16 or f/22 to keep everything in focus. A flash with Guide Number 30 or higher will let you position the flashguns a metre away and they'll still be powerful enough.

A single flashgun can give great results, but two or three will open up your creative options. Look out for Slave mode, which makes the flash fire whenever another flash is triggered. This means you need only one trigger device to control a group of flashguns. Also look out for flashguns that come with a mini stand so they can be positioned upright without additional equipment. Most can tilt the flash head up and down, which is useful for aiming the light. Some also pan left and right, but that's only really relevant when mounting the flashgun on a camera.

Another option is mains-powered studio flashes, or strobes, as they're known. These remove the need for batteries and are quicker to refresh between shots. Most also include a modelling light, a low-power lightbulb that lets you see how the strobes are illuminating the subject before you shoot. This is particularly useful for portrait photography, and comes in

handy for smoke photography too. There are lots of accessories for studio strobes, from softboxes for diffusing light to barn doors and snoots for directing it more precisely.

You'll need to position the flashguns or strobes away from the camera and trigger them remotely in sync with the camera's shutter. There are two ways to do this: with a cable or wirelessly. Some cameras and flashguns have a suitable PC sync socket for triggering flashes with a cable, but this isn't so common on consumer equipment. You could get a hotshoe-to-PC adaptor for around £10, but bear in mind you'll need two – one to sit on the camera, another for the flashgun to sit on – plus a cable to connect them. In our experience, a wireless system is just as reliable, no more expensive and far more convenient.

The iShoot model we used is no longer available, but searching Amazon for 'wireless flash trigger' brings up lots of examples, with prices from £10. These include one battery-powered transmitter that sits on the camera's hotshoe and one or more receivers that the flashguns sit on. The base of the receiver has a tripod thread, so you can use a full-size or mini tripod to position the flashguns. You'll also need some incense sticks.

If you're using two or more flashguns or strobes, consider getting some coloured plastic filters, known as gels. These come in

various sizes, from small rectangles that clip over the front of flashguns to rolls that you can cut to size as necessary. All the colours in the examples shown here were created using gels, with a bit of processing in Lightroom to bring out their intensity.

Don't forget rechargeable batteries for the flashguns and wireless triggers. These costs can mount up, but a wireless off-camera flash system is a huge asset for all sorts of photography projects.

SETTING THE SCENE

The remaining equipment can probably be pieced together from household objects. The objective is to photograph smoke and nothing else, so you'll need a black background. It doesn't need to be huge to fill the frame – around 50cm square is probably enough. However, a bigger backdrop means you don't have to worry about moving it or the camera to ensure that it fills the frame. Black card, a sheet, blanket or coat should do the trick, although bear in mind that whatever you use will probably end up smelling of incense for a few weeks.

The flashguns or studio strobes need to be positioned slightly behind the black backdrop so they don't illuminate it. That means they'll be pointing slightly towards the camera, and this can result in lens flares. To avoid this, use some pieces of card, backs of chairs or whatever else you can find to cast a shadow from the flashes over the camera lens. In the world of studio photography these are known as flags, and you can buy them specially made if you're so inclined.

Another way to avoid light getting on to the backdrop and the lens is with a snoot. This is a black tube that limits light to a specific direction. They're available to buy from around £15, but a piece of rolled up card taped to a flashgun does the job perfectly well. Make sure it's black; otherwise



Photographing smoke is hit and miss, but take enough shots and you'll get a few gems

the light will reflect off the inside of the snoot and leak on to the backdrop and lens.

You'll need something to hold the incense stick in place. Paul Bonnicksen recommends placing it horizontally so the camera only needs to pan left and right as the stick burns. We used a blob of Blu Tack stuck to a marble cheeseboard, placed on a coffee table.

The flashes will illuminate the subject as you take a picture, but you need some light between shots so you can see what you're doing. If you're using studio strobes with a modelling lamp, they'll do the job perfectly. If you're using flashguns, use an anglepoise lamp or torch to shine some light across the smoke, being careful not to illuminate the backdrop or lens. The light from the flashes will be far stronger than this lamp or torch, so it won't affect the appearance of the smoke.

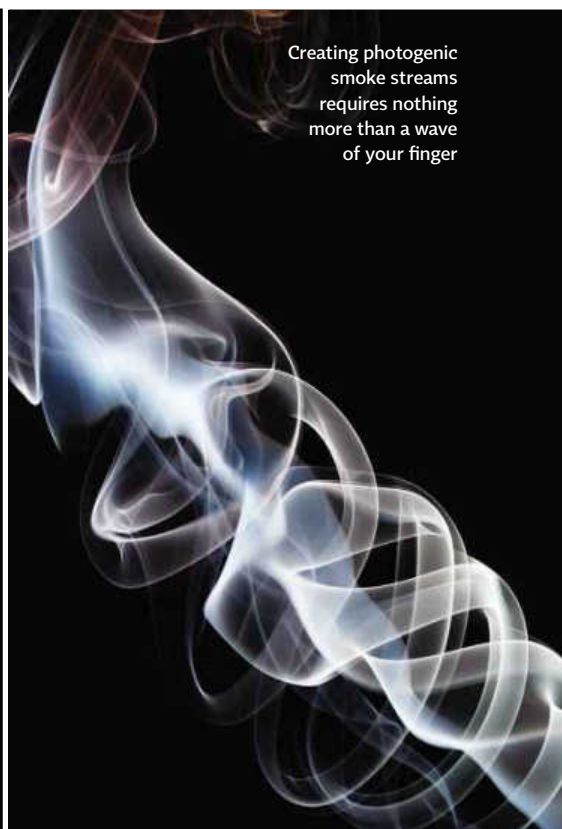
PERFORMING WITH SMOKE

Once everything is in place, focus on the tip of the incense stick, enable Raw capture and switch to manual exposure. Set the shutter speed to the fastest your camera will allow while maintaining flash sync – usually $1/250$ s.

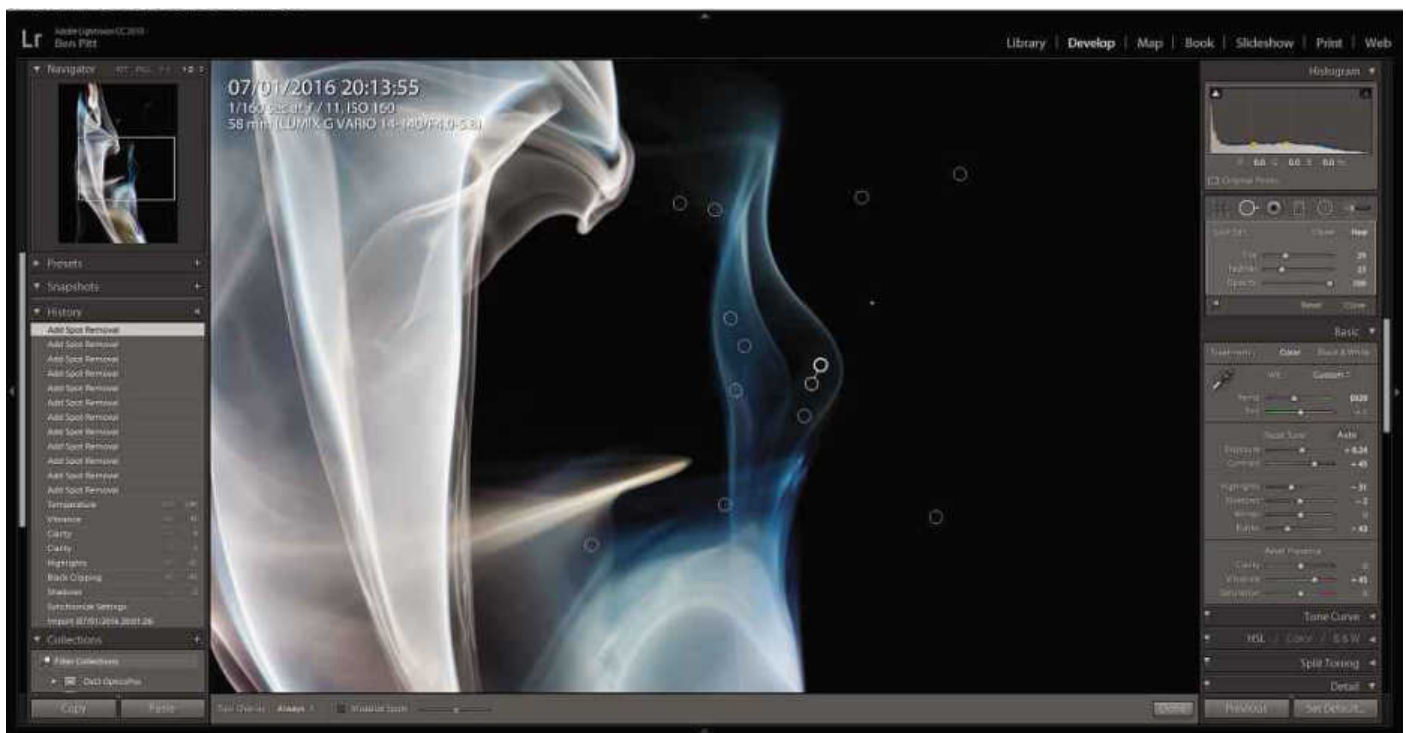
Set the ISO speed to its lowest setting to minimise image noise, and the aperture to $f/16$. Light the incense stick, take some test shots and adjust the intensity and position of the flashes as necessary to get a nicely balanced exposure. The smoke should be bright but not solid white, or else you'll lose the detail within the smoke. You may also want to set the white balance to the Flash preset, although this is easily changed later if you're shooting in Raw mode.

A vertical stream of smoke isn't so interesting, but by introducing some air movement you can create some complex shapes. The easiest way to do this is by hand, and it only takes very small movements to get results. Waft your hand and the smoke will be scattered out of shot, but wiggling a single finger a few inches from the incense stick produces ringlets, spirals and other coherent shapes. Clicking your fingers creates a single kink in an otherwise smooth stream.

On some occasions the heat from the incense stick creates its own patterns, with eddies and ripples appearing without any intervention. The key here is to be ready to



Creating photogenic smoke streams requires nothing more than a wave of your finger



▲ Lightroom is great for cleaning up noise and dust spots, as well accentuating the shapes and colours in the smoke

reframe the shot to capture the most interesting part of the smoke. Be careful to ensure that the black backdrop fills the frame.

Sheet-like shapes were achieved by placing a coaster directly over the incense stick so that the smoke gathered underneath and then flowed over the edge of the coaster. Colours were created by adding a red gel to

and use the number pad to assign a rating to the selected image. Select Library mode and Grid view, click Attributes at the top of the thumbnail display and use the controls that appear to filter the folder based on star rating.

At some point in the selection process you may want to make a start on colour correction. If you've captured in Raw format it's often

other colours in an image. Set the dominant colour to be grey and then boost the Vibrance or Saturation, and all of those subtle variations will be enhanced to produce a richly multicoloured image.

Dust spots are a common problem, as specks of dust in the air are lit up by the flashes. Lightroom's Spot Removal tool makes light work of these. Set it to Heal mode, adjust the size using the mouse wheel so it's a little larger than the spot and click to clone from another part of the image.

We also applied heavy noise reduction, not because there was a huge amount of noise, but because the silky smooth, almost paint-like quality that comes with heavy noise reduction suits the subject matter well.

It's worth experimenting with different orientations and crops. Rotating a photo on to its side or upside down helps to disguise its true identity, and may hint towards other recognisable subjects such as landscapes or reclining figures. Inverting the colours creates an image on white rather than black, and is another way to reinterpret an image. This function isn't supported in Lightroom so you'll need to send the image to a conventional bitmap editor such as Photoshop Elements.

There are lots of other possibilities: combining multiple images to create more complex structures, overlaying them using blend modes, combining them with other photos or even drawing over them to bring out recognisable shapes you can see in the smoke patterns. As with most creative tasks, the best work often comes from having a plan and then seeing where it takes you. **CS**

We were amazed at the variety of colours that came from so few light sources

one strobe, a green gel to another and leaving the third white. Some shots were taken with just two strobes, and a few with just one. We were amazed at the variety of colours that came from so few light sources, although Lightroom had a big part to play in this.

POST PROCESSING

The images shown in this article are the best examples from 971 frames that we captured, all in the space of about an hour. Most of them were pretty boring, and a key part of the process is selecting the best ones.

It's good to have a strategy for this, as otherwise it's easy to lose your sense of what does and doesn't qualify. Our preferred method is to use a five-star rating system, whereby any half-decent image is given one star and then the others are hidden from view. This process is repeated by upgrading the best one-star images to two stars and so on until we're left with a handful of five-star photos. Using this technique, we were able to filter the 971 shots to 451 one-star, 209 two-star, 100 three-star, 54 four-star and 29 five-star photos. The final selection shown here was made from this shortlist.

Various photo-management applications offer this function, including our favourite, Adobe Lightroom. Import the folder of images

possible to reveal details that are hidden in the shadows or highlights at default settings.

Lightroom's colour-correction controls are to be found in Develop mode, to the right of the image preview. The background of your images should be a pure black. It may already be, but Lightroom's Blacks control provides an easy way to make the darkest parts of the frame even darker. Experiment with the other colour-correction controls – Exposure, Contrast, Highlights, Shadows, Whites – to bring out the shapes in the smoke. You should also consider using the Clarity control to accentuate details. We'd recommend using it sparingly, though, as it's easy to make images look obviously processed.

If you've used multiple light sources with coloured gels, the Vibrance and Saturation controls will help to bring out these colours. It's also worth experimenting with the white balance controls. These determine which tone should be rendered as a neutral grey colour, and adjusting the controls pushes colours around the spectrum. For example, a combination of red and white light sources can be made to look white and blue by selecting the White Balance Selector tool and clicking on a red part of the image.

This can work particularly well when there's one dominant colour and hints of

NEXT MONTH

HIGH-SPEED PHOTOGRAPHY

Next month we'll be using our off-camera flash system again, this time to capture objects at high speed

Make a desktop PC from a Raspberry Pi

The updated Raspbian OS makes a Raspberry Pi 2-based desktop PC a genuine possibility. **Clive Webster** shows you the accessories you need



A RECENT UPDATE to the Raspbian operating system added user-friendly features such as booting into a desktop, having a GUI-based configuration system and preinstalled LibreOffice. The combination of this tweaked OS and the much more powerful Raspberry Pi 2 makes it possible to turn a Pi into a proper desktop PC. However, while the Pi 2 is powerful enough to be a real desktop computer, it still lacks a few PC basics, such as a power button, software-based shutdown and a real-time clock. In this month's *Advanced Projects* we attempt to remedy these shortcomings.

We've chosen a PiFace RTC module (for the clock) and a Pi Supply Switch to add the main missing elements to our Pi 2. We've also chosen a case with VESA mount points so we can fix the tiny PC to the back of our screen. If your screen already uses its VESA mounts for its stand, use sticky-backed Velcro strips to stick a standard case to your screen, or else just tuck it away on your desk. The Pi Supply Switch, which houses the new power buttons for your Pi 2 PC, doesn't have a case, so either attach it to the side of your screen with something non-conductive (and claim it's 'an intentional steampunk look') or craft a case using your own ingenuity.

ASSEMBLY

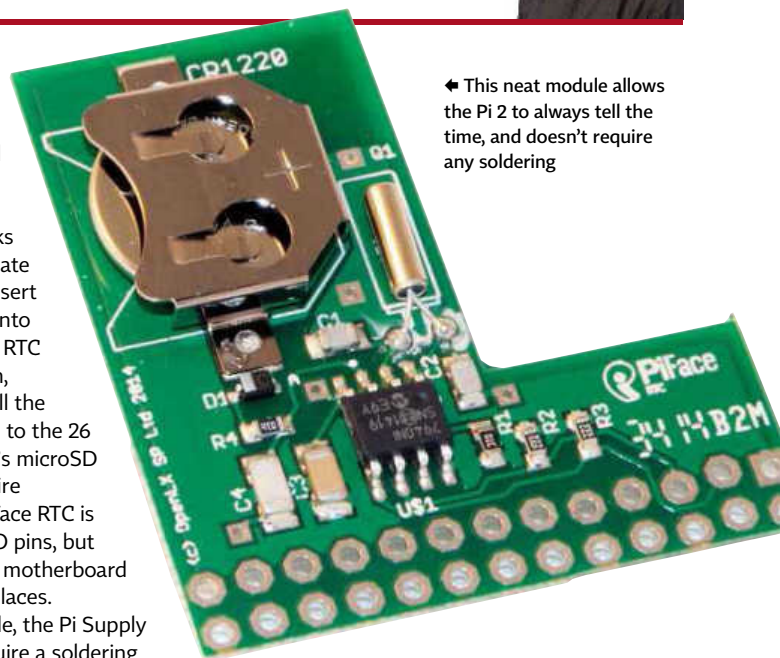
Any PC lacking a real-time clock (RTC) will forget the time and date once it's powered off, ruining date-specific tasks such as sorting files by date or scheduled backups. Insert the tiny CR1220 battery into the holster of the PiFace RTC module, with the smooth, positive side up. To install the module, push it down on to the 26 GPIO pins nearest the Pi's microSD card slot; it doesn't require soldering. Ensure the PiFace RTC is well down on to the GPIO pins, but that it doesn't touch the motherboard of the Pi 2 in any other places.

Unlike the RTC module, the Pi Supply Switch module does require a soldering iron; we recommend a fine tip as the circuit board is very neatly packaged. Follow the assembly procedure on Pi Supply's website (tinyurl.com/ap-power-switch), taking care to correctly identify the resistor values and positions. The 10K-Ohm resistors have colour bands of brown-black-orange, while 1K-Ohm resistors are coloured brown-black-red; the difference is annoyingly subtle, but the orange band tends to be thicker than the red. Also note that only the 22K-Ohm (red-red-orange) resistors sit on the circuit board as a pair.

The double-header cable from the power unit attaches to pins 7 and 8 of the Pi 2's GPIO; with the Pi 2's microSD card slot towards you,

the bottom-right GPIO pin is pin 1 and the bottom-left is pin 2. The Pi Supply Switch is a simple pass-through until some software is installed on the Pi, so it's fine to use the On and Off buttons for now; the Soft-off button won't work until that software is in place.

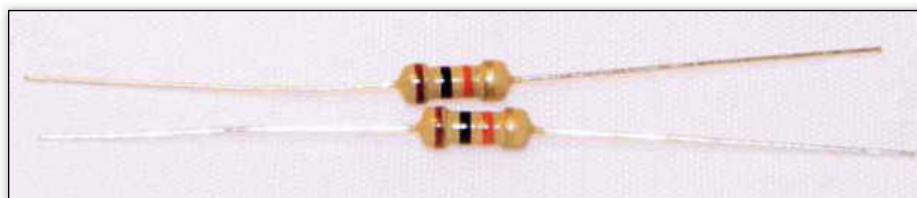
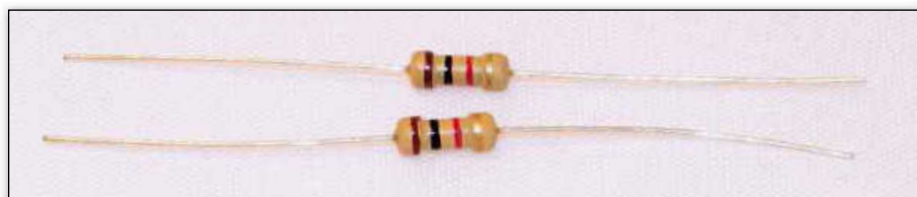
You can now build your case. If you've also opted for the VESA case we used (see our Shopping List), first peel off the protective film from both sides of each Perspex section, punching out the holes and slots as you go. ModMyPi's assembly guide is good (tinyurl.com/ap-vesa-case) but we were convinced the USB-port section was wrong until we turned and flipped the case a few times.



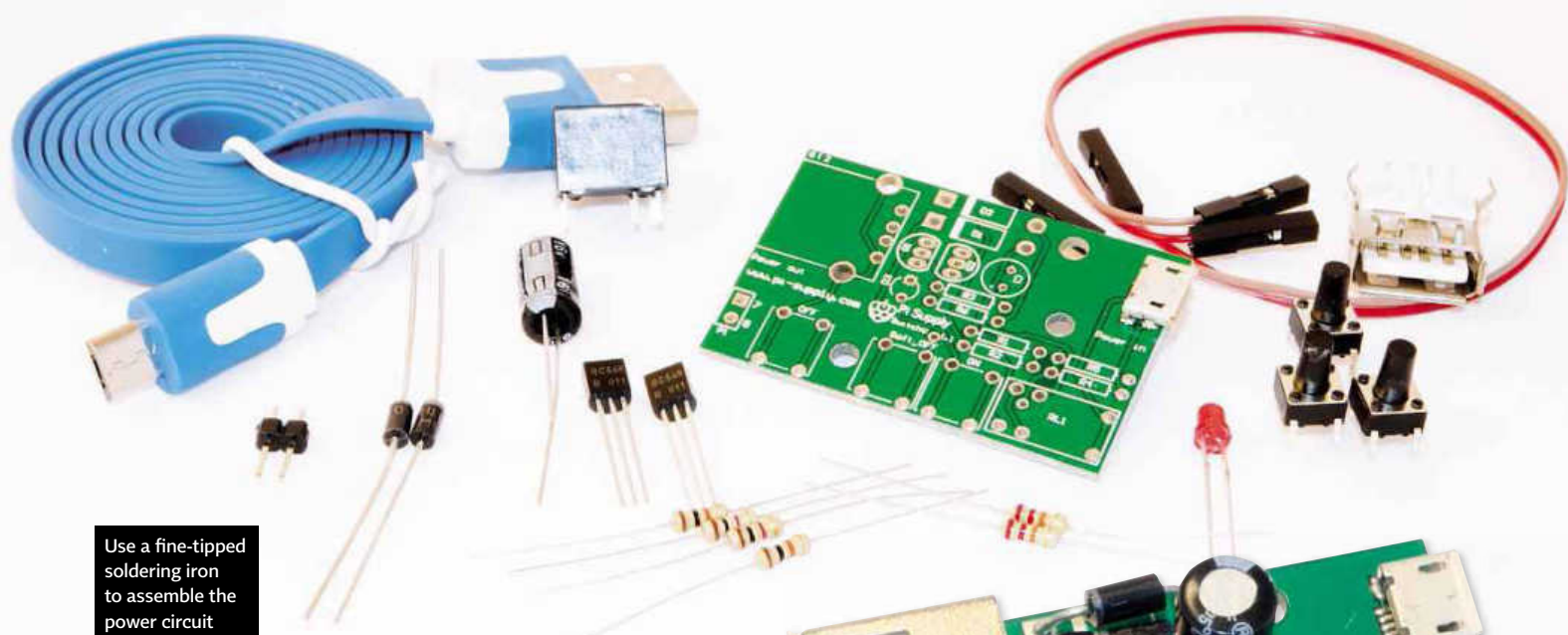
◀ This neat module allows the Pi 2 to always tell the time, and doesn't require any soldering

SHOPPING LIST

Raspberry Pi 2 (RPI-0007) www.modmypi.com	£29.99
Pi Supply Switch (GEN-0015) www.modmypi.com	£14.99
PiFace Shim RTC (FACE-0007) www.modmypi.com	£9.00
32GB Micro SD card www.amazon.co.uk	£8.49
VESA-Pi+ case (MMP-0068) www.modmypi.com	£7.00
5U 2A Power Supply (MMP-0019) www.modmypi.com	£4.99
CR1220 battery www.amazon.co.uk	£1.55
Delivery	£2.99
Total	£79.00



↑ Use the correct resistors in the correct position; the ones with the thinner red band (top) are 1K-Ohm



Use a fine-tipped soldering iron to assemble the power circuit

GETTING JESSIE WITH IT

Download the latest version of Raspbian (Jessie) from www.raspberrypi.org/downloads/raspbian and follow the guide at elinux.org/RPi_Easy_SD_Card_Setup to install Raspbian on to your microSD card. Insert the card into the Pi 2's slot, plug in your screen and peripherals, and connect the Pi Supply Switch to your power source and the Pi 2. Press the Pi Supply Switch's On button and the Pi 2 will boot straight to the Raspbian desktop.

Click Menu, Preferences, Raspberry Pi Configuration and you can set up the Pi 2. First click 'Expand the Filesystem' and then click OK – don't restart yet. Open the Interfaces tab and enable I2C (which enables the GPIO pins). Click OK but don't restart yet. Open the Localisation tab and set the Timezone as 'GB' (or as appropriate). Click OK, and restart; if you're not prompted to do so, do this via the Shutdown... option of the Raspbian Menu.

Once you've rebooted you should update the OS and applications. The quickest way is

via the Terminal, so open that from the system tray (it's an icon showing a black screen, near the Raspbian Menu). Type 'sudo apt-get update' and hit Enter, then 'sudo apt-get -y upgrade' and hit Enter. You'll need to be connected to the internet to update Raspbian.

FOLLOW THE CODE

First we'll set up the RTC module. In the same Terminal window, and with the Pi 2 still online, type the following commands, followed by Enter:

```
wget https://raw.githubusercontent.com/piface/PiFace-Real-Time-Clock/master/install-piface-real-time-clock.sh
chmod +x install-piface-real-time-clock.sh
```

```
sudo ./install-piface-real-time-clock.sh
```

If all goes well, you'll be advised to reboot the Pi and set the date. To reboot, type 'sudo reboot' and hit Enter. Once rebooted, open the Terminal again and type 'sudo date -s "DD MMM YYYY HH:MM:SS"' (for example: sudo date -s "12 FEB 2016 13:34:23"). Now halt the OS by typing 'sudo halt', and, once the OS has definitely stopped, unplug the Pi 2 from the mains and the internet for 10 minutes. Power the Pi 2 back on (but don't reconnect to the internet) and the time shown in the top-left will be correct. If not, try rebooting the Pi 2.

Creating the code for the Pi Supply Switch is even easier: connect to the internet and then open Python 3 (IDLE) and the pre-installed Epiphany web browser. In Epiphany, head to tinyurl.com/ap-soft-off and copy the code from the upper 'Interrupts' section into Python. Then click File and Save As, creating a

The biggest update in Raspbian Jessie is a GUI-based configuration tool (left) rather than the old-fashioned command-line tool in previous versions (below)

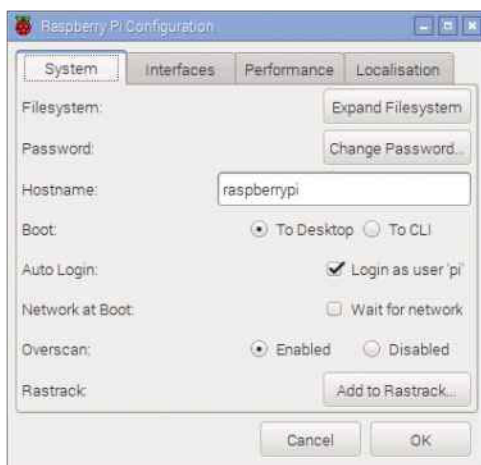
OPTIONAL

USB WI-FI DONGLE

Price £6 inc VAT

Supplier thepihut.com

Rather than route Ethernet cables around the house, just plug in this Pi-compatible USB Wi-Fi adaptor. Larger 5GHz adaptors are rated at up to 300Mbit/s rather than the 150Mbit/s of this 2.4GHz nano dongle, but cost around £15. We've also seen nano adaptors with built-in 6in antennas to increase range and reliability. As yet there are no Pi-compatible 802.11ac Wi-Fi adaptors, only 802.11n.



```
1 Expand Filesystem      Ensures that all of the SD card s
2 Change User Password    Change password for the default u
3 Boot Options            Choose whether to boot into a des
4 Wait for Network at Boot Choose whether to wait for networ
5 Internationalisation Options Set up language and regional sett
6 Enable Camera           Enable this Pi to work with the R
7 Add to Rastrack         Add this Pi to the online Raspber
8 Overclock               Configure overclocking for your P
9 Advanced Options        Configure advanced settings
0 About raspi-config      Information about this configurat
```

<Select>

<Finish>

Additional software

To make your new Pi 2 PC even more useful and enjoyable, you should install some additional software. To install software, open Menu, Preferences, then click Add/Remove Software. Search for each application in the top-left box. Here are the best packages to install.

If you don't fancy the **LibreOffice Writer** word processor, install **AbiWord**. Desktop publishing application **Scribus** is great if you regularly create newsletters or flyers. **PDFedit** lets you edit PDFs rather than just read them (in the pre-installed **Xpdf**). The pre-installed **Claws Mail** is a bit basic, so upgrade to **Icedove**, an unbranded clone of Mozilla's Thunderbird. If you want Google Calendar support and decent MS Exchange support for your email client, consider **Evolution** – it takes an age to load, however.

There are options for every type of programmer. **Gedit** is a basic editor, while **Geany** has more features for everyday code writing. HTML coders should use **Bluefish**, while C, C++ and Fortran experts need **Code::Blocks**. If you need a full-blown development environment, consider **Eclipse**. While working you might want some music, so install **Clementine**. Keep in touch with collaborators with the **Pidgin** IM client and **Hotot** for your Twitter feed.

Creatives have as many options on Linux as coders. Edit audio in **Audacity** and video in **Kdenlive**, while vector-based artists will appreciate **Inkscape**. If the pre-installed Photoshop-like GIMP is too complex, **Pinta** offers a simpler interface. **DigiKam** brings you advanced photo management, including Raw file handling and batch conversions. Meanwhile, **FileZilla** is an excellent FTP program.

To speed up your workflow, install **Synapse** to search for and launch programs with a search box. Google Drive users need **Grive**, while everyone should look at the **Unison** backup application (install **unison-all-gtk**, too). You'll still need to dip into the Terminal every so often, and **Terminator** allows for multiple Terminal windows.

Shutter handles screen captures, while **RecordMyDesktop** allows screen-casting and desktop video recording (install the GTK graphical front-end module, too). **Bleachbit** can clean your system of junk files and shred sensitive ones.

Once the working day is done you can even play some complex games on your Pi 2 PC – try Civilization 2 clone **FreeCiv**. Equally, **OpenTTD** is a clone of Transport Tycoon Deluxe.

➔ The finished Pi 2 PC is capable of handling everyday computing tasks, and even some complex games


OPTIONAL

POWER CABLE WITH SWITCH (1.5M)

Price £4.99 inc VAT
Supplier www.modmypi.com

If the Pi Supply Switch sounds too tricky to assemble (or too expensive with a new soldering iron factored in), try this USB to Mini USB Power Cable with On/Off Switch. You'll have to shut down your Pi 2 PC manually, but then you can kill that annoying red LED by flicking the rocker switch.

Flick it back on and your Pi 2 boots up. Use the cable with a spare 1.5-2A USB adaptor or buy an Ultra HQ Power Supply for £6 from the same supplier.

folder in your 'pi' directory called PiSupply and naming the file softshut before clicking Save. Next, open a Terminal and type 'sudo nano /etc/rc.local' (without the quotes); scroll to the end of the file and add the lines 'python /home/pi/PiSupply/softshut.py &' and 'exit 0' after the RTC code (ignore the quotes). Press Ctrl-X, Y and then Enter to save and exit. Shut down the Pi 2, connect the Pi Supply Switch and boot up using the On button of the Switch. If all goes well, the Pi 2 will halt Raspbian if you press the Soft-off button, after which the hardware will power down after roughly two minutes. 

NEXT MONTH

MAKE YOUR OWN NAS

Take a cheap, off-the-shelf mini PC and turn it into an awesome NAS for all your file-sharing and media-streaming needs

To celebrate Christmas we are offering 10% off all orders until Midnight (GMT) December 25th to use this code (or at least have a play with it and try to get their head round how it works).

```
# Import the libraries to use time delays, send os commands and
import RPi.GPIO as GPIO
import time
import os

GPIO.setmode(GPIO.BOARD) # Set pin numbering to board numbering
GPIO.setup(7, GPIO.IN) # Setup pin 7 as an input
while True: # Setup a while loop to wait for a button press
    if(GPIO.input(7)): # Setup an if loop to run a shutdown command when button pre
        os.system("sudo shutdown -h now") # Send shutdown command to os
        break
    time.sleep(1) # Allow a sleep time of 1 second to reduce CPU usage
```

Add these lines to rc.local to enable software-based shutdowns for your Pi 2

loading a Python file during boot process.

Once you have entered either the interrupt based or while loop based code above into the Python IDE, you then need to create a folder called PiSupply in the /home/pi directory. Save the above code (whichever you choose) in the newly created folder at /home/pi/PiSupply – naming the file softshut.py or similar.

Then open an LXTerminal session, and use the Nano text editor to add some code to enable the Python script we just created to run when the Pi boots up. Type in:

```
1 | sudo nano /etc/rc.local
```

and then add in the following code:

```
1 | python /home/pi/PiSupply/softshut.py &
```

before the line that says:

```
1 | exit 0
```

Press Ctrl+X to exit the Nano editor and when prompted press Y and then Enter in order to save the file you just edited.

Zygote

Human endeavour has reached the pinnacle of its achievements, says **Zygote**, as he wonders how we ever lived without vibrating smalls and pee-powered socks

OFF YOUR TROLLEY

Spencer the robot is blue and white, seven feet tall, has bushbaby eyes, trundles around like a Dalek, and has been on a very useful work experience stint at Amsterdam's Schiphol airport.

Spencer's mission in life is to find lost passengers and guide them to wherever they want to go within the airport boundaries. The robot has built-in maps for fixed objects like walls and doors, and uses laser beams to avoid moving objects such as people and luggage trolleys.

The motivation comes from KLM, which has been racking up losses due to passengers unable to find the correct departure gate and missing their flights, and the airline accountants hope that Spencer can help solve such problems and save them money.

The robot receives instructions via a large touchscreen built into its chest, which avoids any misunderstanding from passengers using voice input for connections to Fort Dix.

SWEET NOTHINGS

Zygote fully endorses a proposed EU recommendation to label branded video games as advertisements. Two-thirds of our primary schoolchildren play an internet entertainment that features sweets, snacks or sugary drinks at least once a week, and go on to consume an additional 72 more calories of crud as a direct result each time. The more they play, the more they ingest.

Unlike TV adverts, which are instantly recognisable, only 6% of parents and children are aware that the sole purpose of video gameplay involving 'edible' treats is to promote sales. Of the 74 million schoolchildren in the EU, 16 million are obese, and over 4 million are so overweight their health is at risk. Bah humbug!

WEB TRAFFIC

The problem of illegal drones is so bad in Tokyo that Japanese police have enlisted the help of

Spiderman. Computer-controlled drones are regularly spotted over restricted areas such as airports, sports arenas and military sites, and one that landed on the roof of the Prime Minister's residence was found to have a payload of radioactive cesium.

Now the Spiderman Drone Squad Department is operating a fleet of quadcopters. These are equipped with three-metre webs designed to snare the rotors of illegal drones and haul them back down to earth. Illegal fliers will be fined 500,000 yen (around £2,900). Although the dangers of these annoying little vehicles are no doubt true, Zygote suspects the web of publicity surrounding the Spiderman police has been created by spin doctors.

SMARTY PANTS

Computerised clothing is changing the way we feel about ourselves. It all began with Wi-Fi-enabled vibrating knickers designed by Billie Whitehouse of the Wearable Experiments company, for what she calls "remote long-distance relationships". Whitehouse has now followed up her excitable pants with a jacket that's a real fashion sensation. That is to say, the wearer feels the sensation of a virtual nudge on the shoulder as a navigation aid.

Meanwhile, Malcolm Xing has designed a wearable body sensor

made from ordinary chewing gum. Up to now, body sensors have used specialist plastics and silicones, but Xing has discovered better sensitivity and flexibility can be achieved by units made from gum chewed for half an hour, sterilised and then mixed with a molecular layer of carbon nanotubes. These chewable body sensors can also detect temperature and humidity changes, and Zygote looks forward to their use in Whitehouse's vibrating knickers, so wandering wearers can tell if they are coming or going.

And while we are on the subject, let us welcome the arrival of wee-fi. Urine-powered socks developed at the University of the West of England are proving remarkably efficient. The wearer pees into their socks via a special tube to the heels, the action of walking then pumps the urine through a series of miniaturised fuel cells, and electricity is generated. Enough electricity to power a wireless transmitter and send regular signals to a computer.

Professor Ioannis Ieropoulos, head of the university research programme, said the socks could transmit the wearer's coordinates in an emergency situation, "and indicate proof of life", seeing as a prerequisite of making fresh pee is to be alive.

MOUSE DROPPINGS

This month's Zygote Award for the Bleedin' Obvious goes to an international group of academics studying how people use their computer mice. After analysing a huge amount of data, the eminent professors have concluded that people experiencing anger, confusion or sadness are less precise in their mouse movements than people who are cool, calm and collected.

Coming soon: conclusive proof that people who do not move their mouse at all are either away from base, asleep or dead.

DOGGONE

It's great to see that respect for the monarchy is not only alive and well in Thailand, but that it extends to the royal pets as well. Even dead ones.

Tiensutham Suttijitseranee is a 58-year-old businessman, and has been sentenced to a modest 25 years in jail for posting an amusing image of the monarch, King Bhumibol, on Facebook. Whereas Thanakorn Siripaiboon is a 27-year-old mechanic, and he has been given an even more modest 37 years for using Facebook to insult the king's mongrel bitch named Thong and recently deceased. Zygote wonders if reverence shown to the dead dog can only be described as barking mad. **CS**



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